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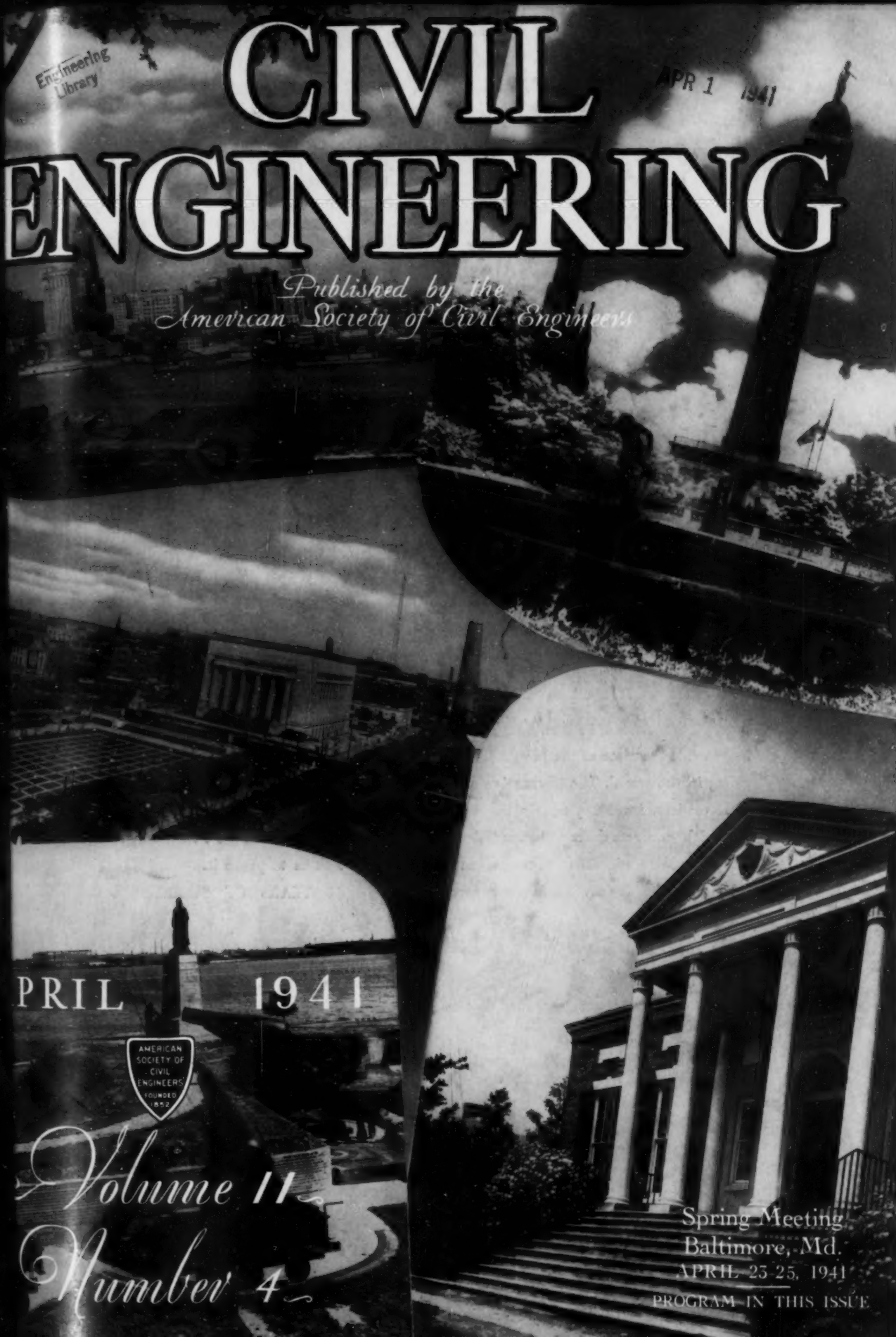

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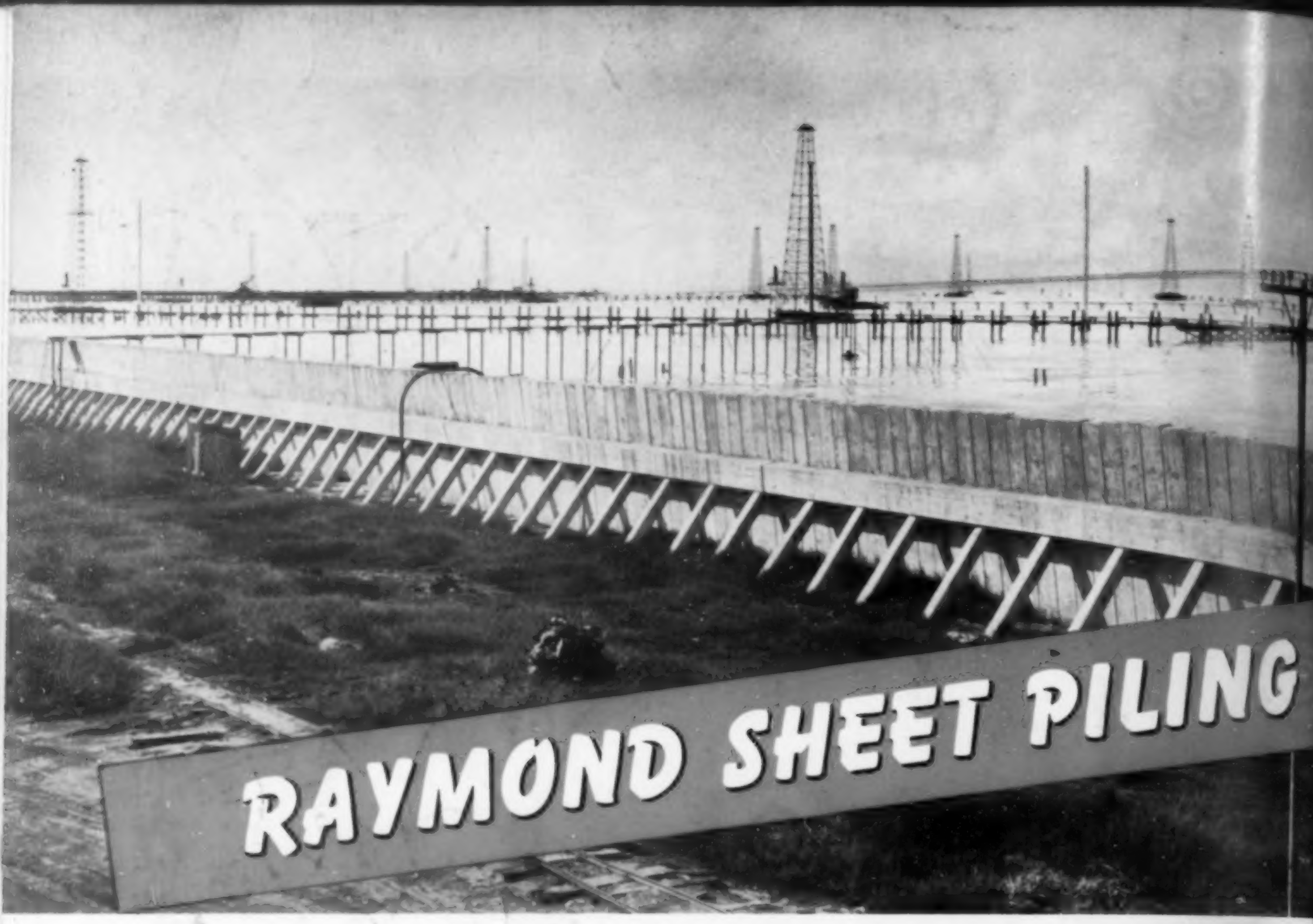
PROGRAM IN THIS ISSUE



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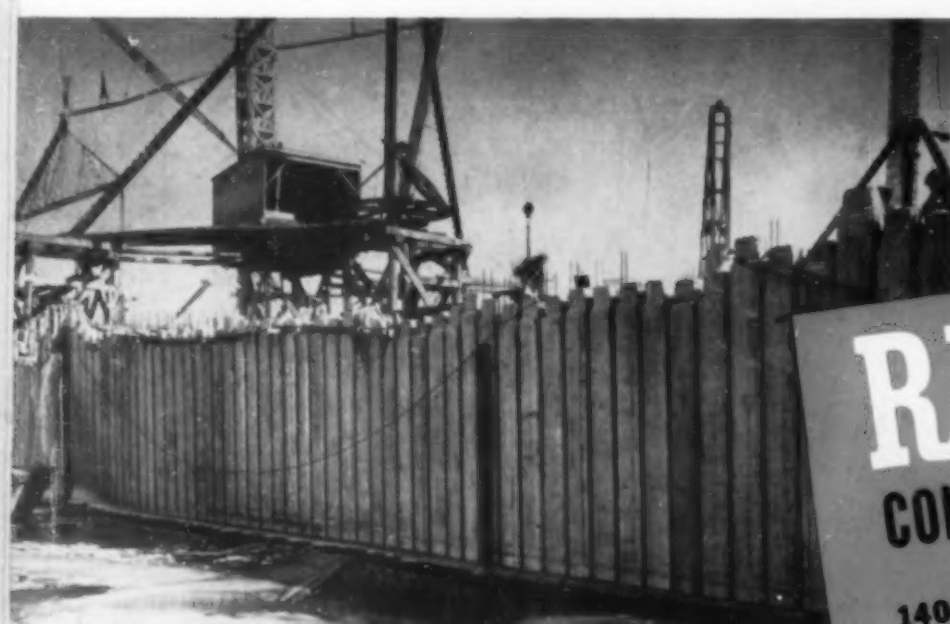

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PROGRAM—IN THIS ISSUE

Among Our Writers

WARREN E. HOWLAND (M.I.T., '22; Purdue, M.S.E., '29; Harvard, S.D., '39) began teaching hydraulics and sanitary engineering at Purdue in 1926 after 4 years of practice in Massachusetts and Connecticut. At Purdue he has done considerable research and has cooperated with the Indiana State Board of Health.

RALPH B. WILEY (U. of Mich., '06) was employed for 2 years under the late John H. Gregory, M. Am. Soc. C.E. Subsequently he has taught at Purdue, spending his summers on engineering work. He is contact member of the Committee on Engineering Education.

RUSSELL C. BRINKER (Lafayette, '29, U. of Minn., M.S.'33, C.E. '39) worked for the Amer. Bridge Co., then entered teaching at the U. of Minnesota. In 1935 he accepted an instructorship at the U. of Hawaii; in 1936 he taught at Worcester P.I. as exchange professor; and returned to Hawaii in 1937 as assistant prof.

FRED V. DOUTT (Ohio State U., B. of Chem. E., 1920), after a year's baptism of fire in the Chemical Warfare Service, was successively employed by the Republic Steel Co., the Ohio State Health Dept. Lab., the Carolina Engineering Co., and Gilbert C. White, consulting engineers. He has held his present position since 1926.

CARROLL T. NEWTON (M.I.T., '33; M.S., '40) was on duty with the 21st Engineer Regiment (Aviation) at Langley Field, Va., before his present assignment to Fort Belvoir, Va. Previously he had spent 2 years with the Fort Peck Engineer Dist. on soil sampling and 1 year with the 5th Engineers at Fort Belvoir.

RANDOLPH H. DEWANTE (U. of Calif. '38) has been employed since graduation as a junior engineer on flood control studies in the Los Angeles and Sacramento Districts of the U.S. Engineer Dept.

E. RALPH STOWELL (U. of Calif., '38) spent several months with the Calif. State Planning Survey before joining the U.S. Engineer Dept. at Sacramento on flood work.

H. G. GERDES (U. of Calif., '22) spent 10 years in California on hydraulic investigation design and construction work, and in 1932 went to the Portland (Ore.) office of the U.S. Engineer Dept., where he was in charge of Bonneville Dam design. From 1935 until July 1938 he was with the Federal Power Commission, and was hydroelectric engineer for the Harza Engineering Co. on the Santee-Cooper Project until his call to military duty in Nov. 1940.

BRUCE D. GREENSHIELDS (U. of Okla., C.E.; U. of Mich., M.S., Ph.D. '34) first taught as an instructor in civil engineering at Marquette University. Since then he has been successively assistant professor at Virginia P.I., professor at Denison U., associate professor at City College of New York, and adjunct professor (highway engineering) at Brooklyn P.I.

FRANK M. MASTERS (Cornell) began work in 1904 as an inspector of bridge materials for Ralph Modjeski and continued in the firm until 1916 when he opened his own office in Harrisburg, Pa. He served as a Major of Ordnance in the previous war, and some years after returning to private practice entered his present partnership.

F. M. KIPP, JR., was with the Maryland State Roads Commission in 1914, and with the Newport News Shipbuilding and Drydock Co., and the Maryland Shipbuilding Co. 1915–1917. From 1917 to 1919 he was lieutenant with the 33rd Engineers, and from 1919 to 1931, asst. civil engineer with the Bur. of Water Supply, Baltimore.

JACOB FELD (C.C. of N.Y.; U. of Cincinnati, C.E., Ph.D.) after 8 years of varied experience entered the consulting field, with emphasis on subsurface construction, in 1925. Soil study has been his hobby for over 20 years, predating his recent interest in soil mechanics.

LORAN D. GAYTON (U. of Ill.) had had a wide experience in structural and water works engineering before being appointed city engineer of Chicago in 1927. He has been on the staff of the city's Bureau of Engineering for 26 years. The South District Filtration Plant, believed to be the largest in the world, was under his direction until Feb. 1, 1941.

ROBERT HALL MERRILL (U. of Mich., '02) entered the professional field in bridge and harbor work in the Lake Michigan region. From 1906 to 1918 he was engaged on the New York Barge Canal. After 3 years on canal work in China, he opened consulting offices with C. W. Spooner in 1921 in Grand Rapids, Mich.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Backsight at a Turning Point

Surveying the Problem of the Lengthened Curriculum

By Warren E. Howland, Assoc. M. Am. Soc. C.E.

and Ralph B. Wiley, M. Am. Soc. C.E.

Respectively Associate Professor of Sanitary Engineering, and Head of the School of Civil Engineering, Purdue University, West Lafayette, Ind.

As the national defense program is thrown into high gear, he shortage of trained engineers becomes painfully manifest and demands increase for special emergency courses, shortened curricula, and a general speed-up in engineering education. While this acceleration in our educational program to meet the present military emergency may be necessary (and to oppose it may be futile) we must not overlook the greater emergency of a different sort which will undoubtedly follow the present one. Then not only will our technical ability be tested to the utmost, but also our morale; and this, we submit, can only be sustained by clear thinking based on a knowledge of human values. Lest we abandon entirely the ideal of a genuinely professional training as we have developed it, let us record some of the aims sought in a lengthening and enrichment of the curriculum and some of the measures proposed and adopted for their attainment.

Arguments for Longer Courses.~At present our curricula make little provision for the humanities and social sciences—for history, art, literature, or philosophy; for political science, economics, sociology, or psychology. While some people emphasize the inadequacy of the technical content, both in specialized subjects and in the basic sciences, such critics usually recommend a rearrangement of course content or curricula; or the provision of a graduate year for a few selected students. The general opinion, however, is that technically our curricula are fairly satisfactory. At any rate, the most urgent and persistent plea for another year of the student's time is that he be given a clearer and deeper understanding of the "human values" and forces in this world.

Also, industrialists clamor for engineering courses in "management" or "leadership"; business men demand training in engineering salesmanship; and engineers themselves seek an improved professional or social as well as economic status, feeling that their education has somehow been at fault. Underlying all these criticisms is a recognition that the engineer's training has failed to impart a knowledge of basically important human experience.

Stressing the Humanities.~Professional men, devoted to the cooperative utilization of the materials and forces of nature for the benefit of man, must have as a part of their professional equipment a knowledge of the nature of man so that they can recognize what is beneficial to him. They must also have the skills and techniques of cooperation to make them efficient in their beneficent enterprise. Thus it appears that human understanding is a necessary part of the professional knowledge of the engineer. Man does not live by bread alone, nor by reason solely either; but also by his emotions, his aspirations, and his enthusiasms.

That the engineer needs a broad social education is true whether he becomes a leader or remains always among the rank and file. It is obvious why those who are to be leaders need such an education, and in this industrial society engineers are and should be leaders. The rank and file need this background too, because in a democracy all citizens should be broadly trained in order to choose their nation's leaders and policies wisely. Muddle-headed thinking can easily lead a democracy to disaster.

Mere technology, however effective as an intellectual discipline, is not adequate to supply this training. Facts, human facts, must be supplied in a setting in which the emotions and sympathies will be guided by intelligence but not caused to atrophy. Strange as it may seem, the habits of clear thinking acquired in the laboratory are not automatically carried over to the fireside, the conference room, or the voting booth; new forms of clear thinking must be developed.

A Basic Need.~It might be supposed that engineers, who are so largely responsible for the increase in the productive capacity of men and of nations, would be

the first to enjoy, or at least to seek to enjoy, the benefits of their own accomplishments; that they would utilize, or seek to utilize in a prolonged period of education, the leisure time made possible by the improvements in productive efficiency which they have brought about. That they do not do so is evidence of the need for the enrichment of their education: they don't know what they are missing.

Our profession is not the only one which has earned the right to a better education and which has paid a thousand times over, and in advance, for the time and money that society is fairly called upon to furnish. Medicine has earned this right, and it, along with sanitary engineering, chemistry, biology, and other disciplines, has in the last fifty years prolonged the average span of life of everyone by more years than the entire duration of its professional training.

But medicine has done more—it has demanded and obtained as its right and need an adequate period for cultural and professional training of its young men. In so doing it has secured for itself a competent leadership and a broadly informed rank and file and thus has assured a future of continuous advancement in service to society.

Counting the Costs. ~Some believe that the cost of an engineering education is already too high—as if the educational wares we are dispensing (inadequate though they have been) were not worth vastly more than the pennies paid in exchange for them! What do these critics mean? Too high for whom—the student? For a number of years it was very difficult to find employment for all who were graduated. Too high for the public? If this is so why do our universities deliberately make a show of the costly non-essentials, such as field houses and stadia, that unhappily accompany the more serious business of education?

Some claim the cost is too high for industry—meaning, we suppose, that the cost to the student of a longer period of college training would have to be borne by industry through higher salaries; meaning also that present engineering salaries are too high. We hear no such complaints from industrialists who employ our men. Rather their plea seems to be that more, and more costly, training of these men is required.

Lethargy Is One Handicap. ~Why then do we not demand in a single united shout that the engineer's training be lengthened by at least one year? Because too many of us do not really appreciate the need for a more liberal education. We read in CIVIL ENGINEERING the testimony of men like Robert E. Doherty, Arthur E. Morgan, William E. Wickenden, Enoch R. Needles, Edwin S. Burdell, et al., and we dismiss it as fine-spun theorizing, impractical idealism, or just plain nonsense. Or we conclude as if with Candide: "Social responsibility, what is that but doing our technical job as well as we can? Let us cultivate our garden."

Little is gained by arguing with older engineers about these matters. Either they live in the intellectual world of our times or they do not. If their only contact with this world is through purely technical reading, then no amount of artificial resuscitation will bring them back to life. If they feel themselves to be in a world of living social ideas, they are bound to read and think about such matters. But, though the older men may be beyond reach, the younger ones are not. Thus it seems to be the clear responsibility of those who think as we do, to seek to lengthen and enrich the education of the engineer.

One Attempt to Liberalize. ~Recognizing this need for "human" understanding, for culture in the deeper sense, or for a liberal education of its students—call it what you will—Purdue University has undertaken to enrich in every possible way the "cultural opportunities" of its campus, especially outside the classroom. Lectures, music, and dramatics have always had their place in regular convocations. In the last few years an all-campus religious convocation program has been added. A rich collection of books has been made readily accessible to all in a browsing room. Traveling libraries and prize literary contests, and vastly improved physical facilities for encouraging the more educative of the student activities, have been provided. Glee clubs, choral singing, band, and symphony orchestra have been made popular.

However, there is a question as to just how much can be accomplished by these means with the present four-year curriculum. Traditional college diversions of little educational value cannot be crowded out over night. And the inexorable demands of our highly technical courses of study crammed into a four-year program leave only a limited opportunity for extracurricular activities of an intellectual nature. Thus we have been led to the five-year program.

Unified vs. Separate Programs. ~In place of a lengthened, integrated program of technical and liberal studies, which we favor, some have advocated a preliminary program of exclusively liberal arts work followed by three or more years of exclusively technical studies. We have observed that many students from liberal arts colleges develop habits of study and thought processes that are not consonant with the rigid disciplines of engineering. Others develop a cleavage between their technical and cultural interests which is rarely bridged. Furthermore, we know that the early professional courses, such as freshman surveying, provide excellent motivation for the younger men at a time when the humanities do not so readily appeal to them. A continuously balanced educational fare seems to be more palatable as well as more nourishing and, on the whole, a better preparation for the multifarious daily demands of later life.

Two new, optional five-year programs have been added to the Purdue curriculum. One of these, to be recognized by a distinctive degree, will include a broadened and integrated band of humanistic studies extending throughout the five years and carefully fitted into the technical program, which will remain unchanged. The other proposes to extend the present program over a five-year period. Nearly a quarter of the entire engineering freshman class and more than a third of the civil engineering freshmen elected the five-year curriculum in June 1940.

A Concerted Effort. ~If, however, this plan does not continue to attract a considerable number of students, it may be necessary for several of the prominent engineering schools, acting in concert after securing the wide approval of the profession, to abandon the four-year programs altogether. But the success of either scheme will depend very largely upon the attitude that the profession expresses toward the lengthened program. Those in sympathy with these views should let their voices be heard in the councils of the profession, and at once.

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Sidelights on Construction in Hawaii

Puka-Puka Rock, Sea Air, and Termites Make Life Interesting for Island Engineers

By Russell C. Brinker, Jun. Am. Soc. C.E.

Assistant Professor of Civil Engineering, University of Minnesota, Minneapolis, Minn. (At Present on Leave from University of Hawaii)

STRATEGICALLY important—and the present swarming ground for so many of our members—the Island territories and bases command our genuine interest. Also, for the most successful defense effort, it is helpful if the engineers in the home office know something of the local conditions under which the field forces operate. Such anomalies as the specification of steam heat for buildings south of the Tropic of Cancer surely need not be repeated. The glimpses of Hawaiian practice shown here by Professor Brinker disclose a number of conditions that might not be anticipated and taken into account by the average mainlander.

PERHAPS the first and most important consideration influencing construction in the Hawaiian Islands (Fig. 1) is the question of materials. There are no steel or cement mills and the local supply of lumber for general building purposes has long since been exhausted. These things must be imported, so that delays in receipt and difficulties in the event of error are magnified. Any study of local construction, whether concerned with bridges, dams, buildings, or homes, must necessarily consider the relative advantages and costs of the various materials in great detail.

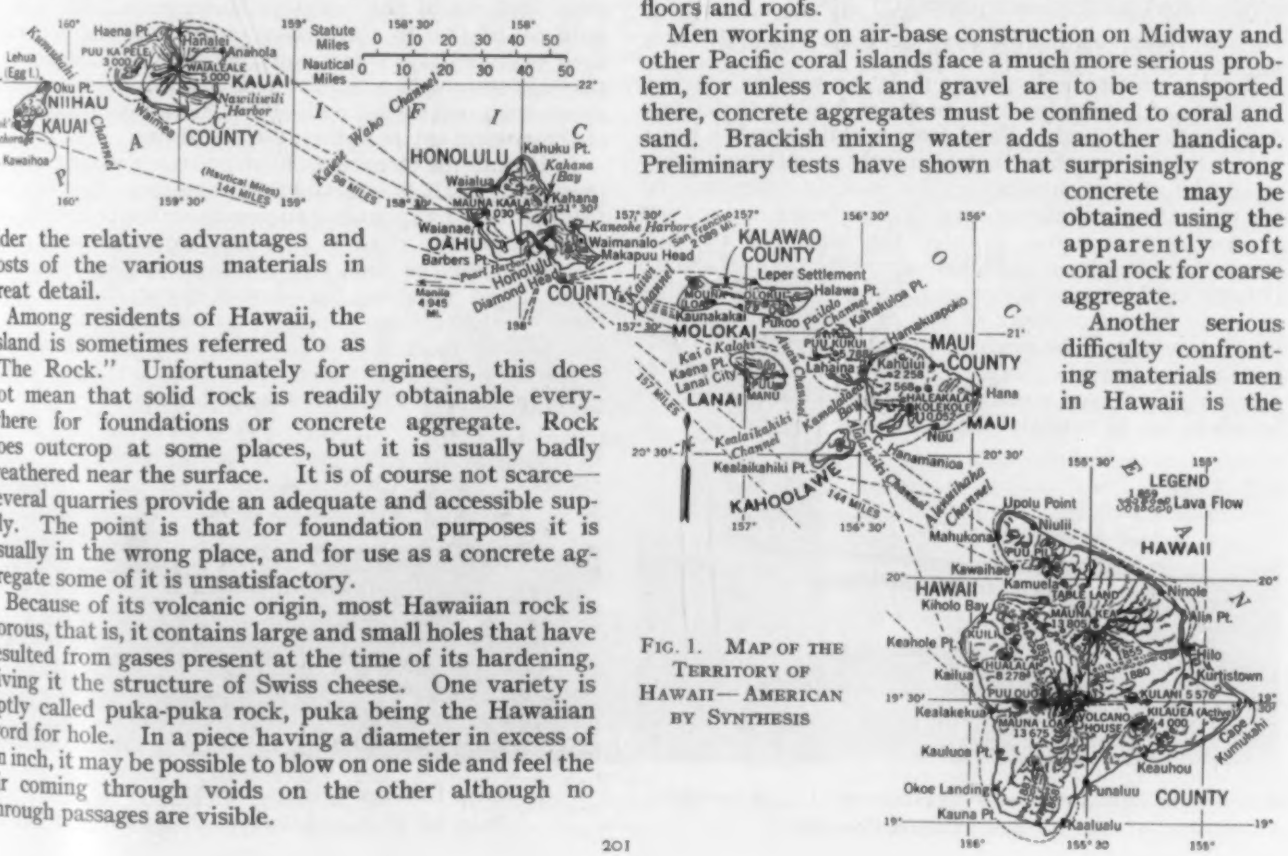

Fig. 1. Map of the Territory of Hawaii—American by Synthesis

Among residents of Hawaii, the Island is sometimes referred to as "The Rock." Unfortunately for engineers, this does not mean that solid rock is readily obtainable everywhere for foundations or concrete aggregate. Rock does outcrop at some places, but it is usually badly weathered near the surface. It is of course not scarce—several quarries provide an adequate and accessible supply. The point is that for foundation purposes it is usually in the wrong place, and for use as a concrete aggregate some of it is unsatisfactory.

Because of its volcanic origin, most Hawaiian rock is porous, that is, it contains large and small holes that have resulted from gases present at the time of its hardening, giving it the structure of Swiss cheese. One variety is aptly called puka-puka rock, puka being the Hawaiian word for hole. In a piece having a diameter in excess of an inch, it may be possible to blow on one side and feel the air coming through voids on the other although no through passages are visible.

In some past specifications, only a small portion of such rock was permitted to be mixed with the more solid basaltic type. This led to difficulties in determining just where to draw the line, since the same quarry may produce both good and bad rock, and specific gravity tests are of little help in grading. Actually the porous rock produces a good concrete, although it is somewhat lighter in weight than the ordinary variety. Some engineers prefer the puka-puka rock for use in light-weight floors and roofs.

Men working on air-base construction on Midway and other Pacific coral islands face a much more serious problem, for unless rock and gravel are to be transported there, concrete aggregates must be confined to coral and sand. Brackish mixing water adds another handicap. Preliminary tests have shown that surprisingly strong concrete may be obtained using the apparently soft coral rock for coarse aggregate.

Another serious difficulty confronting materials men in Hawaii is the

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WAINEA BRIDGE ON THE ISLAND OF KAUAI

almost complete lack of gravel. At a few places, chiefly far up the valleys, very limited supplies may be found in the vicinity of old or existing stream beds. Usually the small amount available and the necessity for careful washing make it unprofitable to work these isolated deposits. As a substitute, crushed rock which passes a No. 3 sieve is used. The material retained on the No. 3 sieve is called No. 3 crushed rock and is used for coarse aggregate in most local mixes, although No. 2 crushed rock sometimes replaces it.

SATISFACTORY SAND AVAILABLE AT LOW COST

Sand is present in large quantities on various beaches, but some of it contains coral particles, broken shells, or a combination of both. Sand from certain beaches has a better reputation than that from others, although practically all of it is satisfactory for making concrete. At the present time Waianae sand (from a beach in a section known by that name) is rated the best. In 1:3 mix briquettes, it gives a higher strength than standard Ottawa sand because of better grading. It is likely that in many cases a mixture of two or more poorly graded beach sands could be made to produce a highly desirable product for use in concrete. Until sand becomes more expensive, however, stock piles will probably continue to be made up of material from a single beach.

In Hawaii the use of steel bridge trusses is limited by the serious corrosive effects of the salt air, which is felt everywhere except perhaps in the higher mountains. Also, the frequent light showers with the sun shining during them or immediately afterward, have a highly destructive effect. An indigenous handicap to steel maintenance is the so-called "liquid sunshine"—that famous Hawaiian product which consists of a light mist wafted down from the mountains by the trade winds while the sun blazes overhead. In general it is felt that even though a concrete structure is proved by comparative design to be somewhat higher than a steel one in first cost, its choice can be justified by the reduction in painting charges.

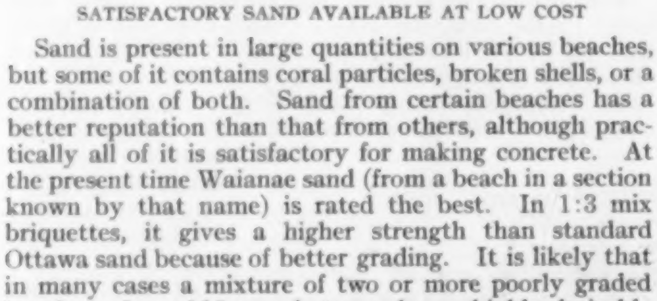
Some concrete structures also have required repairs in cases where reinforcing bars were placed—or pushed by flowing concrete or workmen's weight—too close to the forms. Moisture has caused rusting and spalling so that cleaning of the steel and guniting are frequently needed to prevent complete loss of bars. One of the photographs shows a light reinforced concrete bridge that illustrates this condition. Rusting of the steel adjacent to the bent corners has progressed to the extent that stains beginning at the joint extend the height of the legs.

Only three steel truss bridges are in use on the entire Island of Oahu. All are inland near Schofield Barracks and thus perhaps a little less likely to be affected by the salt air. All are short simple spans, singly or in series; the longest has three trusses of about 90 ft each. At Pearl Harbor steel cranes, loading towers, and other units are in operation and probably could not be replaced by structures of any other material. The Oahu Railway has two steel bridges, one a plate-girder crossing of the Kamehameha Highway.

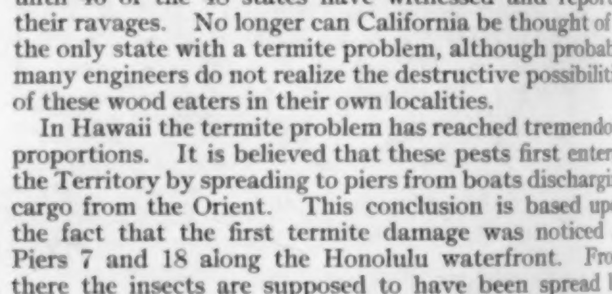
A PROBLEM OF SERIOUS PROPORTIONS—THE TERMITE

The great handicap to timber construction in Hawaii is the termite. Once seen only in biological collections in most sections of the country, these pests have spread until 46 of the 48 states have witnessed and reported their ravages. No longer can California be thought of as the only state with a termite problem, although probably many engineers do not realize the destructive possibilities of these wood eaters in their own localities.

In Hawaii the termite problem has reached tremendous proportions. It is believed that these pests first entered the Territory by spreading to piers from boats discharging cargo from the Orient. This conclusion is based upon the fact that the first termite damage was noticed at Piers 7 and 18 along the Honolulu waterfront. From there the insects are supposed to have been spread by street cars (the ends of which were often riddled) and by progressive movement along pole lines, until now every part of Oahu and the other Islands is infested.



RUST STAINS DISCLOSE THE PENETRATION OF "LIQUID SUNSHINE"
All Steel Needs Careful Covering



HAWAII'S LONGEST TRESTLE HAS TWENTY-SIX BENTS
Bays Are 16 Ft, and Greatest Height Is 162 Ft

Illustrations of the damage done by termites are available everywhere. Practically all poles carrying utility lines are now creosoted by pressure methods, with a retention requirement of at least 8 lb of creosote per cu ft of wood. Nevertheless, while a good penetration has been obtained, the large butts are sometimes not impregnated near the center. Consequently a few poles have been found in which a central cone or cylinder has been eaten out up to a height of 15 ft. When within about a half-inch of the creosoted portion, however, the termites find the wood unpalatable and go no closer. In this case, the wood removed is of least value structurally, and the poles are not seriously weakened. Teak, Australian cypress pine, and greenheart and mora from South America are considered naturally termite-resistant, but their cost is much greater than that of treated species in general commercial use in the United States.

Baseboards and walls of school and other buildings are often so hollowed out by termites that holes can be easily punched through the wood by hand with an ordinary screwdriver. Even ivory keys on a piano, lead plates protecting a tank, and conduits carrying telephone wires have been pierced by termites. It is doubtful whether for large structural members any method other than pressure creosoting is satisfactory. Certainly if timber connectors are to be used, holes should be bored for them before the timbers are placed in the creosoting tank. The Islands do not have satisfactory facilities for treatment; hence all creosoting must be done on the mainland prior to shipment. This results in some difficulties, since the cutting and fitting of pieces, which should be complete before creosoting to insure protection of all surfaces, must be carried out far from the construction site.

Clay tile has been used sparingly on the Islands. The establishment of a local plant for its production might change this situation but it is doubtful whether the market could support it. Two local companies do manufacture concrete hollow tile, which is coming into widespread use, especially in the many new apartment buildings. Ordinary building bricks must be imported from the coast and are used frugally in deference to their high cost. Most of the better local roads are being surfaced with bituminous products, which are available about as readily as on the mainland. There are few concrete streets or highways.

The price of concrete per cubic yard is appreciably higher than on the mainland, the cost of reinforcing steel somewhat greater, and steel plates and sections about the same. The cost of sand in Hawaii and even in Honolulu may vary widely, depending upon the location. Whereas sand may be obtained for 25 to 50 cents a cu yd at some beaches, individuals requiring a limited quantity may have to pay $4.00 a cu yd. Practically all sand is trucked from source to job, the hauling representing almost the entire cost.

One factor in structural design that may be legitimately minimized or even neglected in Hawaii is the effect of temperature changes. Whereas in some states a temperature variation of 150 F or more is possible, in Honolulu the maximum range is only 32 F—from 56 to 88 F. As a result, temperature stresses are less vital factors. Concrete spans of 60 ft have been built without rockers, shoes, or bronze sliding plates, and show no ill effects. In some cases a bearing area of concrete has been merely smoothed with a trowel to provide for movement. Other designs have utilized building paper placed between member and support.

Federal Roads Administration

Honolii Bridge on the Island of Hawaii

Federal Roads Administration

Timber Structures Require Termite Protection

In recent years, plans requiring government inspection have usually included shoes or rockers in order to insure approval. Lack of appreciation of special local conditions is probably responsible for this waste. There is even a case on record of a government building for which the plans specified steam-heat radiators in accordance with mainland standards.

With Reference to Earthquake Stresses

In Hawaii little if any attention has been paid to incorporating earthquake-resistant details in design. The Islands have experienced earthquakes of a minor nature but none of dangerous intensity, although their location and makeup should warn of possible serious tremors. The earthquake of 1938 gave a hint of the damage that might result. This quake was centered in the ocean bed several hundred miles from any of the Islands but the short periods during which it casually vibrated all of them were not pleasant ones. Plaster was cracked in some buildings, a few windows broken, and new additions separated from old structures. Damage to load-carrying members was in general slight except for several structures on the Island of Maui (which was nearer the epicenter), but only a few buildings were pronounced unsafe until repairs were made.

Hawaii receives the ministrations of the gentle trade winds but has never felt the destructive velocity of a typhoon or hurricane. The value of 30 lb per sq ft usually used for wind load provides a large factor of safety. Rainfall on the Island of Oahu varies from about 18 in. a year at Waikiki to over 260 in. on the uninhabited mountain peaks a few miles away. Abundant fresh water is thus available—and this is fortunate because the porous nature of the soil makes irrigation necessary. Incidentally, a rain gage on top of one Hawaiian mountain recently annexed the world's record with an annual rainfall of 656 in. Some mountains are honeycombed by water-collection tunnels, and the proposed vehicle toll bore to connect Honolulu with windward Oahu will derive some of its income from the collection and delivery of ground water.

Several local buildings have shown interesting foundation characteristics.

One, erected on a deep layer of blue laterite, has an unintentional "floating" foundation. The adjacent ground slopes downward from the back of the structure toward the front, that is, along the short axis. During the rainy season the soil becomes saturated, swells, and moves the building upward and laterally In the dry season the laterite dries out somewhat and the structure settles back into place. The floor of one of the basement rooms—placed without ties to the walls—moves up and down more than 1/2 in. relative to the walls.

Federal Roads Administration

KEAIWA FLAT-SLAB BRIDGE OVER A FLASH FLOOD CHANNEL
Raised Curbs Are the Only Beam or Girder Element, Depth, 16 In.; Spans, 25, 30, and 25 Ft

Another building a few hundred feet away is on a deep layer of blue laterite at the west end and a 6-ft layer at the east end. The structure tilts backward and forward daily, even hourly, as indicated by a seismograph in the basement. In the daytime the east and north ends rise; at night the west and south ends rise. The north-south rocking effect about the long axis of the building is greater than the east-west rotation and amounts to about one second of arc.

As foundation problems go, the construction of a new railroad line over a swamp and shallow pond—the Moanalua project—provided considerable interest. A pile-and-trestle bridge a mile long was first proposed but was partially abandoned in favor of an ordinary fill. For this fill 13 pile bents were driven beyond the rim of solid ground. In driving great care was necessary, for one blow of the 4,000-lb hammer falling 10 ft might cause a 60-ft wood pile to penetrate 10 ft. In other cases, after the piles were driven, the hammer was left resting on them for an hour to induce them to set. But piles thus set in the mud for 24 hours could not be started downward again by driving with the hammer. The driving finally accomplished, temporary cross-pieces and track were laid and filling was begun. Two thousand cu yd were placed by dumping the first day. The next morning evidence of the futility of this method was provided by the sight of fill floating in the muck, some of it yards from the place of dumping— this despite the fact that most of it was "one-man" rock.

A solution based upon results obtained under somewhat similar conditions on the Key West Railway was finally devised. In that project, willow mats were first laid, and the fill was placed upon them. Willow not being an Island product, an economical substitute was found in salvaged lumber. Rafts 15 ft wide and 32 ft long were constructed and floated into position between the pile bents; the fill was placed upon these, and the crossing thus satisfactorily completed.

Highway bridges on the Islands are usually of reinforced concrete. The Ahole Bridge, on the Island of Hawaii, is a two-span rigid frame with end columns hinged at their bases. Rocker columns on a solid pier form the center support. The concrete rocker is perhaps the most interesting feature of the bridge. Although steel rockers are now fairly common for long steel spans, reinforced concrete rockers have had a limited use in America. They have been employed extensively in Europe, but the first description of them in our technical journals appeared in 1927. Standard reinforced-concrete rocker designs have been evolved in Hawaii and their frequent inclusion in bridge construction is a tribute to the progressiveness of the Territory.

The most interesting bridge in Hawaii is the rigid frame built across Wahiawa Gulch on the Kauai Belt Road. This structure, which was described by W. R. Bartels in *Engineering News-Record* (January 27, 1938), is worthy of note for several reasons. It has a curved retaining wall of only 30 ft radius, surmounted by a horizontal arm to counterbalance the horizontal earth thrust and produce an almost uniform foundation pressure. Other unusual features are cantilevered side spans, flanged ribs and architectural curtain walls, and the dissymmetry of the cross section, with a sidewalk on one side only. The bridge has a main span of 125 ft (120 ft clear) with cantilevered side spans of 28 ft 6 in. At the time of its design and construction in 1936, it was believed to be one of the longest rigid-frame bridge spans in the United States.

Federal Roads Administration

WAHIAWA CONTINUOUS GIRDER BRIDGE HAS CANTILEVERED SIDE SPANS

Construction of another dry-dock at Pearl Harbor, the Hickam Field, Kaneohe and other air bases, many large and small buildings, and other essential defense projects upon which perhaps $100,000,000 will be spent during the coming year, may be expected to raise technical problems and revise Island construction methods to conform with large-scale mainland practice. Descriptions of the difficulties encountered and the solutions forthcoming on outlying islands such as Palmyra, Johnson, Midway, etc., where "frontier" conditions still exist, will undoubtedly provide a wealth of unusual technical data.

Some of the information included in this article was originally used by the writer as background for a thesis presented in partial fulfilment of the requirements for the degree of Civil Engineer at the University of Minnesota. For assistance in assembling the data he is indebted to Dean A. R. Keller, Prof. Carl B. Andrews, and Prof. John M. Young (all Members Am. Soc. C.E.), of the University of Hawaii; and to William R. Bartels, Senior Engineer, of the Territorial Bridge Department; to R. S. Mowry and George Dawson of the City and County of Honolulu Engineering Department; to Harry Denison, Superintendent, and Dudley Smith of the Oahu Railway Company; to J. R. Cox of the Joint Pole Committee; to A. S. Kaaua, formerly with the Territorial Bridge Department and now with the Hawaiian Electric Company; to Thomas F. Sedgwich, Honolulu testing engineer; and to H. A. R. Austin, M. Am. Soc. C.E., consulting engineer.

Flood Damage and Clean-Up at Champion Fiber Plant

Sand and Gravel in the Coal—Mud in the Motors—Chemical Storage Dissolved

By Fred V. Doutt

Chief Chemist, Champion Paper and Fiber Company, Canton, N.C.

A MOST unusual storm combination visited Canton, N.C., when the near-record flood of August 13, 1940, was followed 17 days later by a second flood almost 3 ft higher. Rainfall reached 16 in. in less than two days, and runoff from an area of 133 sq miles was as high as 240 cu ft per sec per sq mile. Mr. Doutt's paper was originally given before the Tennessee Valley Section meeting at Asheville and was first published in the "Tennessee Valley Engineer," the Section's monthly bulletin.

FROM 1906 until August 13, 1940, the Canton mills of the Champion Paper and Fiber Company were operated at a site on Pigeon River without interruption by floods. In 1928 a flood stage of the river threatened but did not invade the mill. However, there was considerable loss when a timber bridge leading through the wood yard and a steel bridge to the mill village were destroyed.

But on August 13, 1940, and again on August 30, the mill was flooded (Fig. 1) and all operations were suspended. Flood damages can be divided into three classifications. The greatest damage is that to equipment and structures essentially needed for operation. The second category is the damage to raw material, material in process, or finished product. This, together with the interruptions in production, seriously embarrass a producing organization in the business world. This loss of production constitutes the third class of loss, and is reflected in the community by the loss of income to the employees.

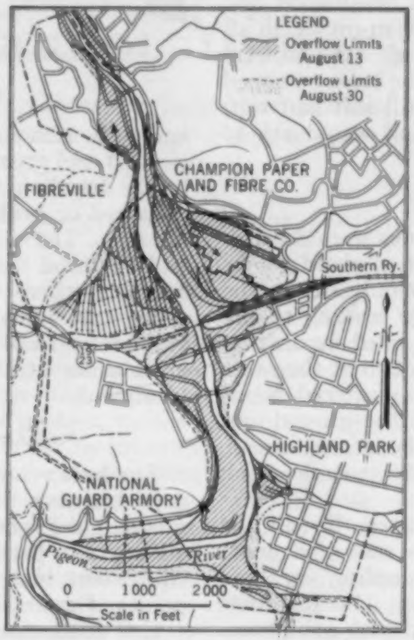


Fig. 1. Area Flooded at Canton, N.C.

Materials lost at Canton include coal, wood, chemicals, chestnut extract, pulp, and paper products. About 6,000 tons of coal were made useless when the flood water mixed the coal with silt, gravel, and sand so completely that no salvage was practical. From the wood yard, 2,000 cords of wood were floated down the river. Of this about 40 per cent was later salvaged by picking it out of fields and other places downstream where it was deposited when the floods receded. The salvage costs were equal to the first cost of the wood.

Chemical losses occurred in two ways. The greater quantity was dissolved and borne away when water invaded the storage rooms. In this way 200 tons of salt and salt cake, 200 tons of lime, and 60 tons of alum were lost. More chemical loss occurred when it became necessary to dump tanks after pumping equipment was stopped by power interruption. In the warehouse 150,000 lb of chestnut extract was wet so thoroughly that it was necessary to rework it with accompanying loss of product and additional processing costs.

Pulp is not hurt by clean water, but the dirt which the flood spread into stocks of white pulp caused much destruction. In the case of pulp and paper, the damaged material was trimmed off the outside until clean stock was found. The dirty stock was reworked into an inferior product, and the wet paper reworked as waste paper.

In the storeroom, machine shop, tool house, electric shop, and some offices the damage to supplies, furniture, records, instruments, and other equipment amounted to a considerable item; and to date (February 15) about $15,000 has been spent in replacements.

Motors and Wiring Cleaned and Dried

The most serious damage in the mill was to electrical equipment. The water supply is from a pump house where the water was 6 ft deep. In this building the motors had been elevated to the roof, but not sufficiently high to prevent damage. Until these motors could be started, no water for washing was available. In the whole plant 300 motors ranging from fractional horsepower to 500 horsepower, together with their switch gear and wiring, were water soaked. Also, sand and mud had been deposited in the bearings and windings. Oil in switch boxes was wet, and required cleaning and drying. The whole clean-up job was greatly hampered by road tar, which floated in from a partially loaded car and bound the silt very firmly to the equipment.

Several methods were developed for handling the motor problem. The larger motors were dried in place. On some, space heaters and glow lamps were wired, and air circulated by fans. On others, electric welders were wired to the windings and the voltage regulated to act as a heater. Temperatures were noted and the motors tested at regular intervals. The bearings and windings were cleaned by washing and brushing.

Pulpwood Storage Yard near Crest of First Flood
A Thousand Cords Carried Away—Much More in Second Flood

Smaller motors were removed from their mountings, torn down and thoroughly washed with clean water. They were then dried in ovens or dry kilns. A large number were suspended over a coke fire and dried. The temperature was checked by feeling the frame with the bare hand. This procedure was labeled "barbecuing."

Small fractional-horsepower motors and many instruments were treated by dipping in carbon tetrachloride and then drying. The results of this procedure were very satisfactory, for the grease, dirt, and water were practically all removed, and the equipment apparently was not damaged.

Conduit was swabbed and in many places heated with blow torches until dry.

Inasmuch as the flood carried much brushwood and silt into the buildings, there was a big clean-up job in all departments. The fact that nearly all drains were plugged made this more difficult, but one lesson learned was to start on the mud while it was still soft and wet, because when dried it stuck tightly and was dusty to remove.

RESIDENCES RENOVATED

In the company's mill village, 60 homes were flooded. The residents lost much furniture and household goods, though they were able to partially evacuate before the water got into the houses. The bridge leading to the village was washed away when debris piled against it, and the water line to the village was broken at the same time. Pulpwood, logs, and brush were scattered about the homes, while mud and silt covered the ground and floors. Two houses were lifted from their foundations, and the river bank was eroded so badly that the back porch of one house was lost.

The first step here was to find quarters for all the people driven from their homes. This was soon done, and the water line was repaired by coupling fire hose between the ends of the broken pipe. The furniture was removed and the houses well flushed with a fire hose. The floors were then sprinkled with chloride of lime and again washed. The weather was warm and they dried rapidly. The soaking had been too much for many floors, and these buckled badly when dried out. Slaked lime was spread about the houses after logs and rubbish had been removed.

Tracks for switching wood to various parts of the wood yard were badly washed in some places and buried in others. The under frames and the wheels were filled with pulpwood and rubbish. Before the cars could be moved to permit realinement and ballasting, this debris

Condition of Storage Basement—Water Line Evid
Stock Piles

had to be removed. The journal boxes of the cars were cleaned and greased before they were turned loose.

The break in the village water line and the several damaged or broken sewers created an additional health hazard. The chlorine in the city water was increased and bacterial tests were made at numerous points, particularly where the lines had been open. No harmful types were found, though there were high total counts. Provisions were made for residents to obtain typhoid inoculation at the mill, and over 6,000 received this treatment.

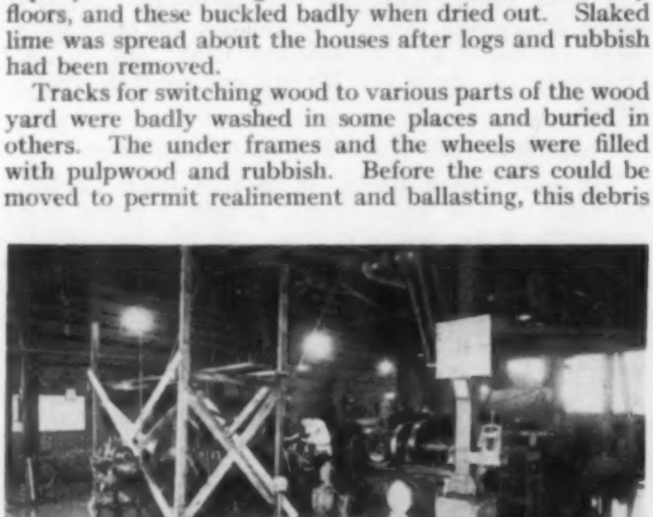
MORALE HIGH IN SPITE OF DAMAGE

The losses due to operating delays varied in different departments. In the August 13 flood, full production was delayed four days, and following the one on August 30, parts of the mill were down a week. The damaged equipment is not expected to give the normal life, as points of weakness will no doubt develop in time.

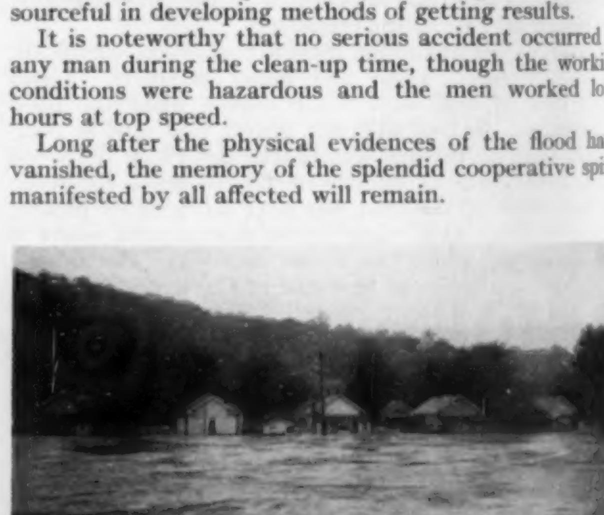
One of the finest things brought out by the flood is the splendid manner in which the staff of repair men worked long hours in filthy mud to correct the mill conditions. The electrical staff particularly were ingenious and resourceful in developing methods of getting results.

It is noteworthy that no serious accident occurred to any man during the clean-up time, though the working conditions were hazardous and the men worked long hours at top speed.

Long after the physical evidences of the flood have vanished, the memory of the splendid cooperative spirit manifested by all affected will remain.



Machine Shop After Second Flood
Sand and Silt Collected in Motors and Gears



Pigeon River at Its Worst
Homes of Employees Suffered Heavy Damage

Official Photograph, U.S. Army Air Corps

HEAVY CONSTRUCTION MACHINERY ACCOMPANIES 21ST ENGINEER REGIMENT (AVIATION) IN REVIEW

Construction of Military Air Fields

Engineer Regiment (Aviation) Organized and Equipped for Earth Moving, Paving, and Erection

By CARROLL T. NEWTON, JUN. AM. SOC. C.E.

CAPTAIN, ENGINEER REPLACEMENT TRAINING CENTER, FORT BELVOIR, VA.

SINCE its inception more than a century ago, the Corps of Engineers has been charged with the duty of providing adequate communication routes for the armed forces of the United States. Engineer forces in war zones have always had to provide and maintain roads and railroads, with the necessary bridges, to meet the tactical and logistical requirements of the infantry and artillery. Similar service must now be rendered the Air Corps by providing air fields and their access roads.

The Air Corps retains primary responsibility for the selection of all the air-field sites to satisfy the needs of strategy in defense or offense. Many factors of course enter into the final choice of a specific location in a certain general strategic area. Among these are accessibility for supply and troops, meteorological conditions, presence of natural or artificial flying hazards, and such engineering considerations as ease of grading, load-bearing capacities of soils, drainage possibilities, and general economy of time or money. Engineer officers are detailed on the staffs of all large Air Corps organizations to assist in any matters where construction engineering advice is required. The Air Corps has recently established four Air Districts in the United States in each of which there will eventually be a well-planned system of main air bases and subbases. The selection of sites in these districts will be a function of the Air District staffs, and the Corps of Engineers will do the construction.

Construction of the recently acquired military bases in British outlying possessions off our Atlantic Seaboard has also been assigned to the Corps of Engineers. To discharge this function, the Eastern Division of the Engineer Department was established with headquarters in Washington, D.C. The Air Corps, in coordination with the District Engineer of the Engineer Department in the field, and the other government agencies concerned with airport construction, especially the Civil Aeronautics Authority, is making a comprehensive index of all existing air fields, proposed or potential, civil or military, federal, state, municipal, or private.

QUICKLY prepared advance air fields for shifting battle conditions are a relatively new concept. Large permanent military air bases meet the needs of peace and mobilization and must be provided with elaborate service and supply facilities. But if such bases are difficult to protect from enemy attack, the temporary fields may be built in large numbers on terrain more favorable to dispersion and concealment of ground installations. Construction of permanent fields is now progressing under the direction of District Engineers, and in the event of war, the construction of temporary fields and the maintenance of other fields will be the mission of the new engineer regiment. This is another article in the series on military phases of engineering arranged through the cooperation of the Chief of Engineers.

From the type and number of planes expected to use the field, the minimum requirements as to length and width of runways are determined. In practically all cases, even though it is contemplated that only the smaller type of ships will use the field, an area large enough to permit eventual expansion to a size suitable for the largest bombers is arranged for at each site. Ample space for expansion may be just as important at a military air base under present conditions as it is at the small municipal airport of a fast-growing modern city. In fact, failure to provide such space might necessitate eventual abandonment of the site in favor of a less desirable location with the required area.

Meteorological conditions of precipitation, temperature, and prevailing winds are studied from all available data, preferably using averages of not less than ten-year intervals. The windage data are referred to the engineering section of the Office of the Chief of the Air Corps and a tentative layout of runways is made from a plot of the "wind rose." The placement of all facilities on the field hinges upon the runway layout. To conform to the requirements of the Air Corps unit to be assigned to the field, the hangars, aprons, taxiways, control tower, warehouses, fuel storage, cantonment area, and connecting roads and railroads are spotted in their most practical and efficient positions on the tentative layout. This layout is surveyed on location and the final plan drafted by the District Engineer in the field, showing relation of runways to existing structures and connections of roads and railroads to existing lines. The completed plan is resubmitted to the Office of the Chief of the Air Corps for final adjustment and approval.

Construction of the field proceeds under the direction of that District Engineer in whose geographical area the field is located. He prepares the details and specifications and makes the decision as to the actual type of construction, the only requirement being that the demands of the Air Corps for size and load-bearing capacities be met. Standards of construction are dictated throughout

CONSTRUCTION TROOPS USE LATEST EARTH-MOVING EQUIPMENT FOR AIRPORT GRADING

by the best civilian practice. The majority of the work is performed by contract through the local Engineer Office, although force account may be used as required in the interest of speed and economy.

In air-field construction soil surveys assume a place of high importance and are carried out to a large extent during the initial layout program. Borings in general need only be deep enough to locate the water table and to probe into high ground that is to be cut. Cut areas are investigated to determine the presence of undesirable rock, and for analysis of the cut material to determine its usefulness in fill. Soil borings locate such material as sand and gravel, that can be economically used as aggregate or as a filler in paving operations. In order intelligently to design an efficient drainage system, the water table must be located and the seepage or percolation characteristics of the soil cover analyzed by a series of permeability tests. In cases of extensive hydraulic fills, where material is fine grained and the drainage path is long, and in cases of rolled fills on soft foundations, consolidation tests are required to establish the time when stability will be realized. Tests are made on surface soils to determine bearing capacity for runways, and if the field will not naturally support plane loads the soil is investigated with a view to stabilization.

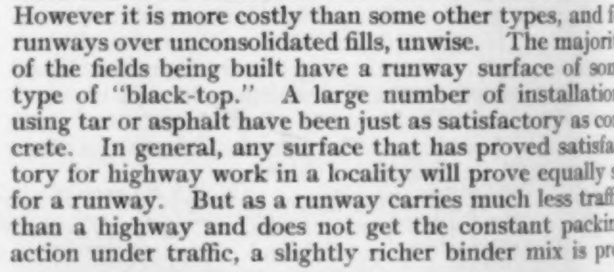
GRADING AND DRAINAGE DOMINANT PROBLEMS

Ordinarily the greatest item in air-field construction is grading. Seldom is a location found that does not require a large amount of earth movement. The ideal site has a natural slope of about 1 to $1^1/_2\%$ and allows rapid runoff of surface water without erosion. From the standpoint of aircraft operation alone, field grades should be held under $1^1/_2\%$ whenever possible. Particular attention is given to all fills to insure firm bearing. The fills are spread in thin layers and compacted by sheepsfoot or other rollers and tractor treads. Constant control by competent inspectors is necessary to insure maximum compaction. As has been the case with many municipal airports, no doubt some of our new permanent military fields will be located adjacent to the seacoast or other waterways and the fill will be provided hydraulically, a dredging procedure with which the Corps of Engineers is most familiar. When fields are located adjacent to waterways, considerable study is given to the eventuality of flooding. In some cases, a system of dikes and levees may be installed to keep back the high water. The grading plan takes into consideration the floodlighting of the field to prevent change of grade lines from intersecting lines radiating from floodlight positions. Failure to consider this item would result in night shadows that from the air would give the illusion of depressions. It may also be necessary to clear the approach zone of trees, structures, and sometimes even earth mounds.

Drainage is the prime item to assure constant operation in all weather. Sandy or shell-type soils with their high percolation rate are excellent for all-weather use, but most sites can be used over their entire area only in dry weather, for standing or percolating water weakens the bearing capacity to an alarming degree. The runways at least must therefore be well drained (Fig. 1).

When practicable the whole field may be drained with a herringbone pattern of perforated metal or open-joint tile laid in gravel. For the runways alone, two systems have proved successful: (1) gutters of impervious paving discharging through gratings into catch basins connected by pipe outlets, and subgrade drainage into gravel-filled troughs containing open-joint drain tile beneath the gutters; and (2) instead of gutters, French drains containing perforated drain pipe along the edges of the runways, with the upper layers of the gravel loosely bound with a bituminous material so that voids in the bound gravel permit the entry of water. The upper surface of the gravel in the latter case constitutes part of the runway shoulder. Surface openings in each type have disadvantages; in the former it is likely that the grating will be a slight hazard to a plane wheel passing over it, and in the latter the small voids in the surface gravel are apt to plug easily with dust, mud, or ice.

Any permanent type of air field has some type of stable all-weather paving on the runways. Reinforced concrete has been considered the best in most locations. However it is more costly than some other types, and for runways over unconsolidated fills, unwise. The majority of the fields being built have a runway surface of some type of "black-top." A large number of installations using tar or asphalt have been just as satisfactory as concrete. In general, any surface that has proved satisfactory for highway work in a locality will prove equally so for a runway. But as a runway carries much less traffic than a highway and does not get the constant packing action under traffic, a slightly richer binder mix is pre-



HALF-YARD CLAMSHELL ASSIGNED TO AIR-FIELD WORK
Machine Has Shovel, Dragline, and Pile-Driver Attachments

ferred. Clay-bound gravel has in some cases proved very good, although the possibility that gravel particles will injure propellers deserves attention.

The lighting and control system is designed by the Air Corps in conjunction with the District Engineer for the specific field under construction. The system is in most respects similar to that of a high-class municipal field with wind-direction indicator, runway marker lights, boundary and flood lights, light beacons, and radio beacons. The installation of utilities such as power, gas, water, and sewage rests to a large degree with the District Engineer, who makes sure that the demands of the occupying Air Corps units are satisfactorily met. Roadways, sidings, fuel storage, shops, and hangars are contracted for and built in accordance with Air Corps plans and specifications.

Concealment of major bases from enemy observation is almost an impossibility. However, camouflage and deception in airfield construction are now the subjects of strenuous research by the Corps of Engineers; in the selection and construction of some of our bases they are receiving as careful consideration as any vital engineering feature. The use of grassed, painted, or otherwise treated runways to make them inconspicuous is being

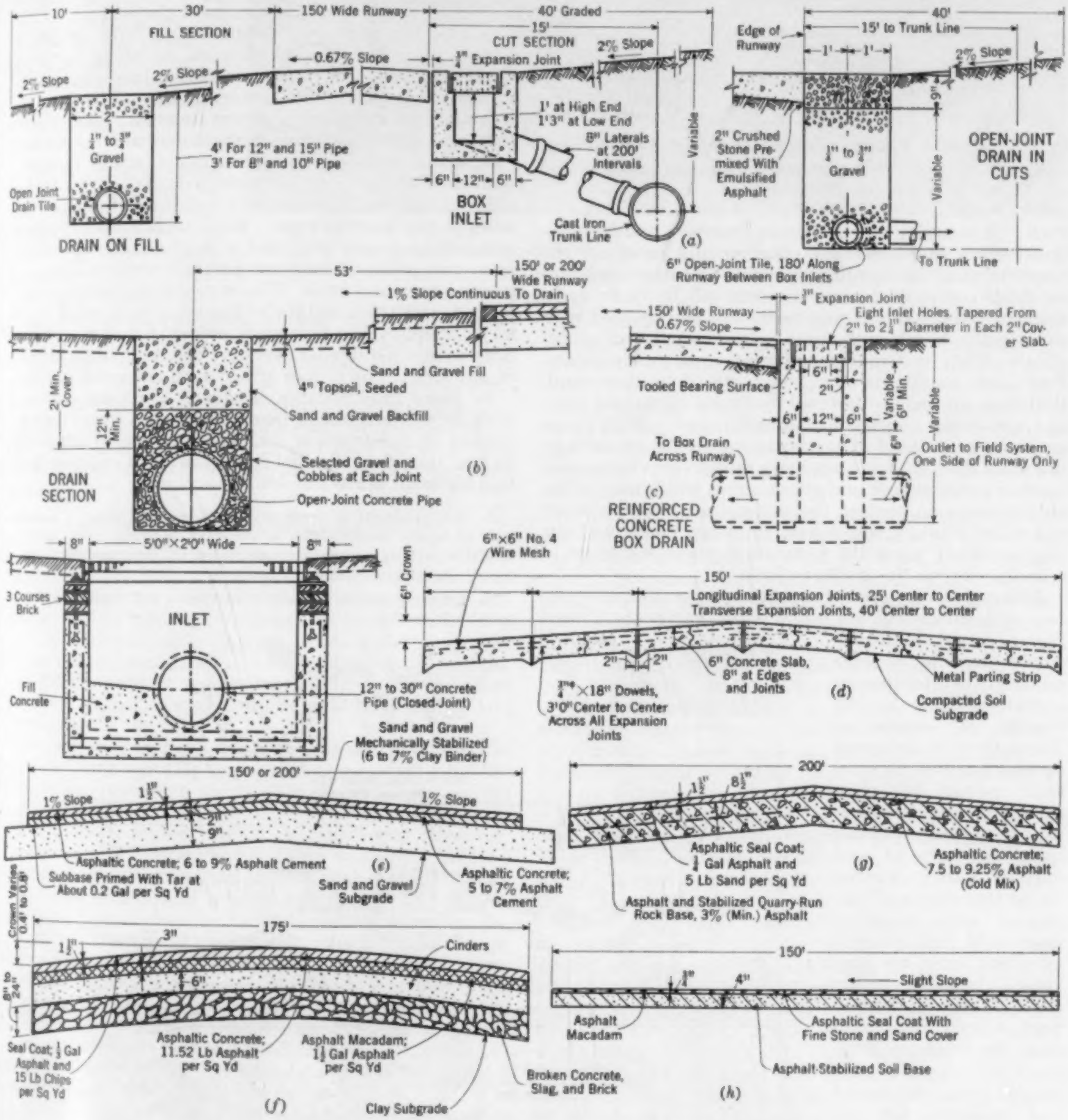


FIG. 1. DRAINAGE AND PAVEMENT DETAILS AT EXISTING MILITARY AIR BASES

(a) Western Mountain: Box Inlets Provided in Cut Sections Only. (b) Middle Atlantic: Grating Is Designed to Carry Wheel Load of 32,500 Lb Plus 50% Impact. (c) Gulf: Removable Concrete Slab Covers Are 6 In. Thick, 2 Ft Long, and Continuous Along Drain Except for 1-Ft Cross-Struts at 11-Ft Intervals. (d) Concrete Laid with Road Paver, Machine and Belt Finished. (e), (f), (g), (h) Asphaltic Concrete Pavements in Middle Atlantic, North Central, Central Pacific, and Southwest Installations, Respectively

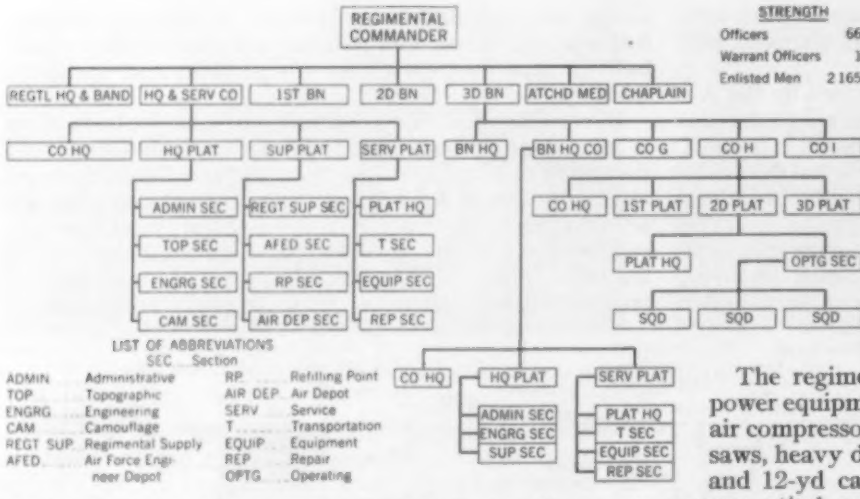


FIG. 2. PROPOSED CHART FOR ENGINEER REGIMENT (AVIATION) Battalions Provided with Headquarters Companies Can Operate at Widely Separated Points

tried. The laying out of dummy runways and installations serves to confuse the observer and misdirect the bombers' aim. It is entirely possible that near some major fields complete dummy airports will be built, as in Europe. Many of our new fields will be provided with considerable bomb protection by the installation of duplicate utility systems, including separate power plants. Fuel and munitions are being stored underground. Buildings are being dispersed and some shops and services are being constructed underground. With large major bases, instead of concentrating all the air units at the main field, subbases are being built to provide accommodations for pursuit and attack ships, which take to the air on alarm to protect the major base. Anti-aircraft and other artillery will defend the main bases, and the Engineers will place the foundation works for these in accordance with the artillery plans.

Although a very extensive program of permanent military airfield construction is now under way in the United States, actual conditions would demand a large number of temporary operating bases in the theater of operations. These must be provided on short notice at strategic points to meet rapidly changing situations. Construction speed is essential and only the bare necessities for getting planes off the ground and supplying them with fuel and ammunition may be provided. As this is characteristically engineer work, a new type of troop unit, the Engineer Regiment (Aviation), has recently been developed and equipped for the purpose.

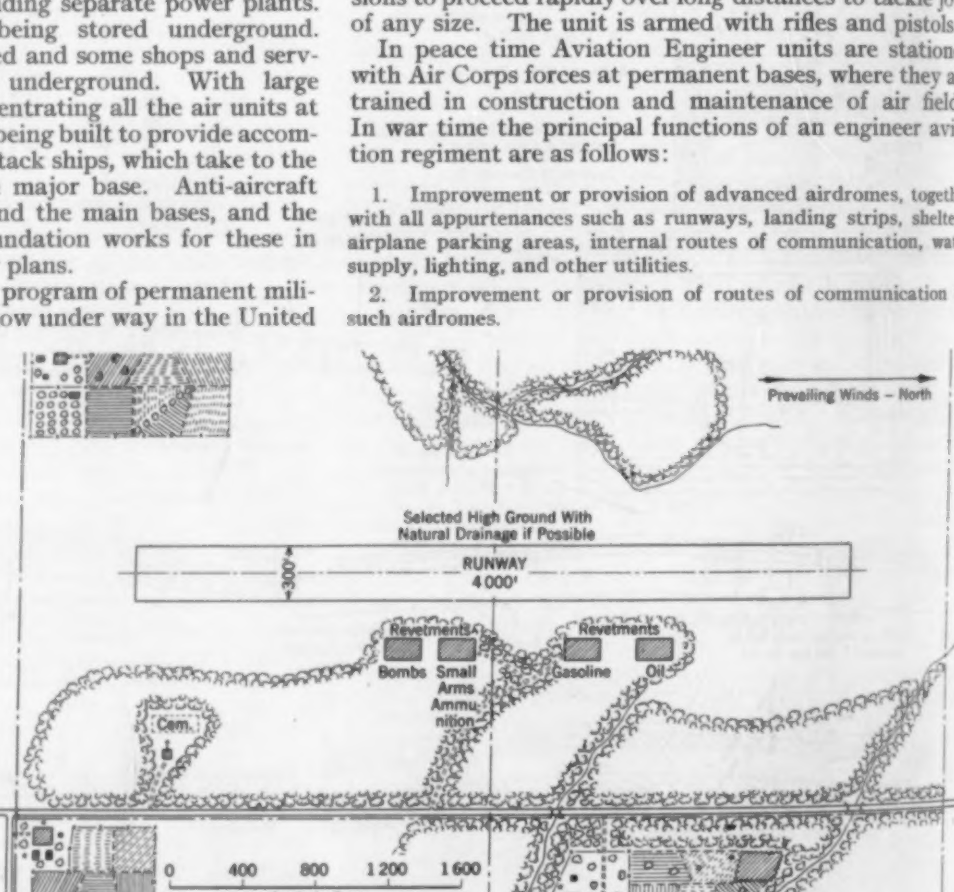
The organization of this unit is based on such time-proved outfits as Engineer Combat and General Service Regiments with a Headquarters and Service Company and three battalions, at present totaling over 1,100 men and officers. It is contemplated that the strength will soon be increased (Fig. 2). The Headquarters and Service Company includes personnel and facilities to meet such specialized requirements as the production of maps and plans, a special camouflage unit, and a heavy construction unit. The individual battalions supply the mass man power for the various engineer tasks.

The regiment is furnished with a large amount of power equipment for earth work, including motorized air compressors with such air tools as jackhammers and saws, heavy diesel road graders, carry-all scrapers of 9 and 12-yd capacity, a power trencher, 30-ft tractor cranes, a timber clearing unit, sheepsfoot and rubber-tired compaction rollers, plows and rooters, power shovels, a road plant-mix apparatus, concrete mixers, and a fleet of continuous-tread tractors with bulldozers from the medium to the heaviest type. Hand tools consist chiefly of ordinary carpenter sets, and a large number of shovels, axes, and picks. There are portable water supply and power generating units. The regiment is completely motorized, with truck and trailer transportation for all equipment, supplies, and personnel, enabling it or its subdivisions to proceed rapidly over long distances to tackle jobs of any size. The unit is armed with rifles and pistols.

In peace time Aviation Engineer units are stationed with Air Corps forces at permanent bases, where they are trained in construction and maintenance of air fields. In war time the principal functions of an engineer aviation regiment are as follows:

1. Improvement or provision of advanced airdromes, together with all appurtenances such as runways, landing strips, shelters, airplane parking areas, internal routes of communication, water supply, lighting, and other utilities.

2. Improvement or provision of routes of communication to such airdromes.



From "Construction of Military Airports," by Maj. F. D. Gore, Air Corps

FIG. 3. EMERGENCY AIRPORT NEAR FRONT LINES IN THEATER OF OPERATIONS
A Base of This Type Is Used for Fuel and Ammunition Servicing Only

3. Provisions for gas-proofing and bomb-proofing essential parts of such installations.
4. Camouflage of advanced airdromes and other Air Corps installations.
5. Map supply.
6. Assistance in the anti-mechanized defense of advanced airdromes by construction and defense of road blocks and by combat against raids delivered by ground forces.
7. Assistance in the defense of advanced airdromes against air attack.
8. Maintenance and repair of airdromes, especially after damage by enemy bombers.

Official Photograph, U.S. Army Air Corps

FINAL GRADING AND PAVING OPERATIONS AT A MILITARY AIR BASE
Open, Level Terrain Adjacent to Site Will Permit Future Expansion

The engineer aviation regiment is both mobile and flexible. Its elements are employed on tasks that are usually scattered over a wide area. The requirements of the Air Force for engineer work in various portions of the theater of operations vary widely with the movement of the supported ground troops and the aerial activity of the enemy. By the proper use of its mobility and flexibility, the engineer aviation regiment can quickly concentrate well-trained units with great work capacity on emergency tasks at vital points and then disperse them again in order to carry out less urgent tasks in scattered areas.

ADVANCE FIELDS FOR LIGHT AIRCRAFT

In advance operations the Air Corps usually will require fields for only the light types of ships, such as observation planes. Sites are chosen where clearing and grading will be held to a minimum, as on cultivated land or in natural clearings. For temporary as for permanent bases, natural and artificial obstacles must be avoided, and the site must be readily reached from existing roads in order to facilitate the supply of fuel, material, and munitions.

Runways are laid out to conform as nearly as possible to the existing topography yet with consideration for the direction of prevailing winds. On the major part of the field, clearing may consist merely of removing brush, stumps, walls, fences, stones, or buildings. However, where trees are common the runways will seldom be long enough without the removal of some timber. In so far as practicable this should be removed to give the appearance of a natural clearing for cultivation rather than for runways. Grading of the runways may be impossible to conceal from air observation for any length of time; however, if the job is accomplished with great speed the mission of the assigned planes may be carried out before the enemy realizes a forward base is being prepared. Such a case creates the demand for highly trained construction troops and for an adequate pool of fast-moving motorized equipment.

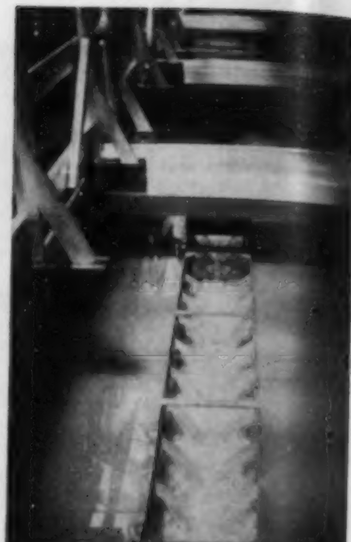
If the temporary base is to be used for any considerable time, adequate drainage must be provided. The field is almost useless unless it can be utilized in all weather. There is seldom time for the installation of drains, catch basins, and drain pipes, so the area and especially the runway must be graded to provide rapid surface runoff. As the situation develops, if the field is required for longer use and considerable traffic, improvements can gradually be made. Drainage and runway surface are very intimately related. There can never be a stable runway subbase on soil that retains water. Where the natural sod or soil of the field is not sufficiently stable to withstand constant traffic in all weather, some type of hasty paving is imperative. In this connection an understanding of soil mechanics and soil stabilization is indispensible. Construction of a subbase with the proper mixtures of gravels, sands, and clays from local sources is ideal but can seldom be realized. Whatever type of well-drained base is prepared, there are unlimited possibilities for stabilizing the surface—with tar, asphalt, calcium chloride, or portland cement, any of which can be procured quite easily throughout the country. On sites where it is very difficult to secure the desired bearing power, resort may be had to perforated metal panels designed to be laid in interlocking pattern to produce a runway. Results from tests of this type are satisfactory, but procurement is difficult and the units are bulky and heavy to transport, requiring a very large amount of transportation for any considerable number of panels.

As in the construction of the major bases, by far the most difficult mission of the Engineer Regiment (Aviation), in conjunction with the construction of advanced bases, is concealment of the installation from enemy observation. Concealment, deception, or misdirection is attempted by the camoufleurs with the regiment. Planes are parked around the edge of the field, backed into woods, and covered with camouflage nets. The field itself is made to appear as cultivated, if possible, by breaking up the line of the runway with simulated roads and fences, or with sods or grasses of the same texture as the surrounding field (Fig. 3). Any necessary structures that cannot be concealed in woods should appear like farm buildings. On a temporary base, housing cannot be provided for operating personnel; the major portion is quartered some distance away, leaving only necessary servicing crews right at the field. Bombproofs are almost impossible in such an installation, but some protection may be afforded by revetments of sand bags or logs covered with trees or banked with hay.

Flow in Effluent Troughs

Application of Experimental Data to Design of Sedimentation Basins

By Randolph H. Dewante, Jun. Am. Soc. C.E.
and E. Ralph Stowell
Junior Engineers, Corps of Engineers, Sacramento, Calif.



One of Notched Troughs in Richmond–Sunset Sedimentation Basin

The method of withdrawing the effluent from sedimentation basins by means of a system of troughs gives promise of considerable advantage over older methods. Operating installations at Springfield, Ill., Toronto, Canada, the Chicago Sanitary District, and the Richmond–Sunset Sewage Treatment Plant in San Francisco have indicated both that the resulting overflow velocities are reduced and that approach currents are better directed to avoid disturbance of the settling solids.

To seek a quantitative evaluation of the discharge to be expected from troughs with either notched or continuous crests, the writers undertook a series of experiments in the laboratories at the University of California. One-quarter scale models of the large troughs at the Richmond–Sunset plant were used.

As a result of a large number of observations, on both notched and continuous crested troughs, it was found by logarithmic plotting that the discharge, Q, varied with $y^{3/2} = (y_1 + s\,L)^{3/2}$, where y_1 is the depth of water in feet at the closed end of the trough, s is the bottom slope of the trough, and L is the length of the trough. This led to the formula

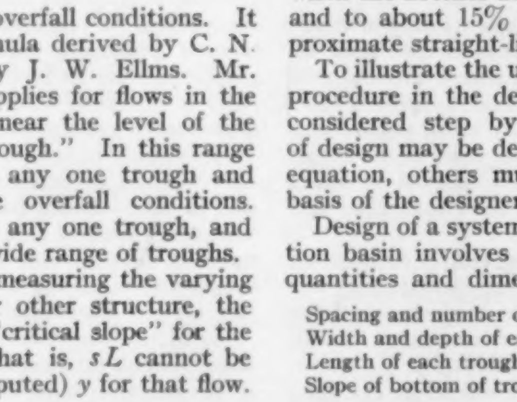
$$Q = C_1\,b\,y^{3/2} \qquad (1)$$

in which b is the width of the trough in feet, and C_1 is a constant whose average value for 29 observations was found to be 2.32.

This coefficient, C_1, is for free overfall conditions. It differs from that given in a formula derived by C. N. Miller in *Water Purification*, by J. W. Ellms. Mr. Miller states that his formula applies for flows in the main discharge channel "at or near the level of the water in the lower end of the trough." In this range the coefficient is a variable for any one trough and necessarily lower than for free overfall conditions. The factor, C_1, is a constant for any one trough, and was found nearly constant for a wide range of troughs.

If the trough is to be used for measuring the varying discharge from a plant, dam, or other structure, the bottom slope cannot exceed the "critical slope" for the smallest flow to be measured; that is, $s\,L$ cannot be greater than the required (or computed) y for that flow. The bottom slope does not affect the discharge unless the critical slope for the discharge is exceeded. (A calibrated float at the upper end of a trough will give a simple, reliable, visible, instantaneous discharge reading.)

As given, the formula applies only to rectangular troughs of constant width. It may be extended to the design of troughs with variously shaped (semicircular, V, etc.) inverts or bottoms by the use of an equivalent rectangular section. A rectangular trough is recommended for simplicity and to save head.



Free Overfall from Reentrant Troughs Into Collecting Channel—Richmond–Sunset Plant

Equation 1 was checked on troughs varying in discharge from 0.02 to 73 cu ft per sec (Table I). The results were within 5% of the measured flow for all troughs. No data were available for checking higher discharges such as are encountered in spillway design.

A second, or modified weir formula applicable to notched troughs was also developed from the tests:

$$Q = N\,C_2\,w\,H^{1.47} \qquad (2)$$

where N is the number of notches in the trough, w is the width of the notches, H is the head on the notch crests in feet, and C_2 is a constant whose value is 3.40.

This equation should be applicable to most rectangular notches where the head is generally greater than the length of crest. However, when some of the notches become partly submerged by water in the trough, the discharge as given by this formula is too large and must be reduced. This reduction amounts to about 5% when the notches at the closed end are submerged 30%, and to about 15% for 50% submergence, with an approximate straight-line variation between the two.

To illustrate the use of these two formulas, the general procedure in the design of a system of troughs will be considered step by step. Although certain elements of design may be determined directly by solution of the equation, others must necessarily be assumed on the basis of the designer's judgment.

Design of a system of effluent troughs for a sedimentation basin involves the determination of the following quantities and dimensions:

- Spacing and number of troughs in basin
- Width and depth of each trough
- Length of each trough
- Slope of bottom of trough

In addition, if the trough is notched, we need to know:

- Spacing and width of notches
- Depth of notches

The number of troughs to be used in the basin will depend upon specific features of the plant and economic considerations. The troughs should be spaced evenly across the basin and not so close together that interference will result. The length of the troughs will also depend upon characteristics of the plant; if they are placed

perpendicular to the flow, the length is fixed by the width of the basin; if they are placed parallel to the flow, they may be distributed over as much as 80% of the length of the basin if need be.

As already explained, the bottom slope is important only when it exceeds the critical, and need not be considered here. A slight slope (say 1 in. in 10 ft) is desirable for drainage. The crest of the trough should be as nearly level as the installation permits. The depth of the notches should be assumed on the basis of the depth of water desired to be taken off, but this assumption might be altered after a trial computation with Eq. 2. A general value for this quantity would be about 6 in. A trial value for the width of the troughs must also be assumed. This could be roughly determined from the relation $Q = VA$, in which the velocity V might be assumed at about 2 or 3 ft per sec in the trough, and the width might be taken as equal to or slightly greater than the square root of A.

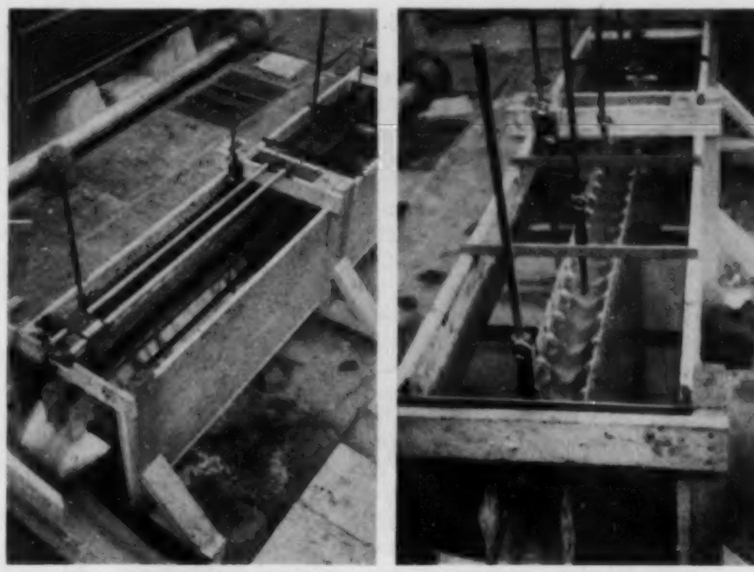
Using values so assumed, the equations may now be applied. Substituting the design capacity, length, slope, and assumed width of the trough in Eq. 1 gives the depth of water in the upper end. Allowing 30% submergence of the notches (this leaves ample freeboard), the depth of the trough at the upper end is found. For example, say the flow to be carried by each trough is 5 cu ft per sec; the assumed width, 1.5 ft; the slope of the bottom, 3 in. in its length of 25 ft; and the depth of the notches, 6 in. From Eq. 1, $5 = 2.32 \times 1.5 \times y^{1.5}$, or

$$y = \left(\frac{5}{2.32 \times 1.5}\right)^{0.667} = 1.274 \text{ ft or } 15^1/_2 \text{ in.}$$

Then y_1, the depth of water in the upper end, would be equal to $y - sL$ or $12^1/_2$ in. If at this flow the notches are submerged 30% (say 2 in.), the depth of the trough at the upper end must be $16^1/_2$ in.—call it 17 in. The depth at the lower end would be 20 in.

To determine the number and size of notches, Eq. 2 is used, substituting for H the depth of notch assumed and for Q the design capacity increased by a factor depending on the submergence of the notches at the closed end of the trough (see the succeeding example). Solving this equation yields the value of Nw, which is the total crest length of the notches. Then the width of each notch and the number of notches may be determined if one or the other is established. The number is, of course, twice the trough length divided by the spacing.

To illustrate this procedure, assume the same quantities used in the previous example. As was stated before, for a 30% submergence of the notches at the upper end of the trough, the flow given by Eq. 2 must be reduced by 5%—say 10% to provide a factor of safety. Then the design capacity must be increased



MODELS WITH CRESTS CONTINUOUS (LEFT) AND NOTCHED (RIGHT)
Traversing Point Gage (Left) Determines Water Profile. Far End of Tank Has Baffle and Screen to Reduce Turbulence

by 10%. Substitution leads to $1.10 \times 5.0 = Nw \times 3.40 \times (0.5)^{1.47}$ or $Nw = 4.5$ ft or 54 in.

This crest length could be made up by 54 notches 1 in. wide (27 on each side), 44 notches $1^1/_4$ in. wide, or other combinations. The former would probably be selected, giving a spacing of $\frac{2 \times 25}{54} = 0.925$ ft or 11 in.

These computations do not definitely establish dimensions. The formulas would probably be of greatest advantage in checking the design. At best, they are intended merely to serve as a guide to the designer, who must rely principally on his own judgment.

The writers are extremely indebted to Charles Gilman Hyde, M. Am. Soc. C.E., Professor of Sanitary Engineering at the University of California, for his suggestions. They wish also to acknowledge the assistance of B. Benas, Assoc. M. Am. Soc. C.E., Superintendent of the Richmond–Sunset Sewage Treatment Plant, in obtaining measurements there.

TABLE I. RESULTS OBTAINED USING EQUATION 1

$Q = 2.32\, b\, y^{1.5}$

Location	Installation	Date of Measurement	Measured Discharge Cu Ft per Sec	Computed Discharge Cu Ft per Sec	Percentage Disagreement
U. of Calif., Berkeley*	$4^1/_2$ in. × $4^1/_2$ in. × 72 in.; level weir crests; flow over both sides; free overfall; bottom slope = 0	1938	0.0618	0.0624	+0.97
U. of Calif., Berkeley	$4^1/_2$ in. × $4^1/_2$ in. × 72 in.; notched; notches $1^1/_2$ in. deep × $^5/_{16}$ in. wide, on 3-in. centers; free overfall; slope = 0	1938	0.0156	0.0162	+3.85
U. of Calif., Berkeley	Same as above, except bottom slope = 0.0278	1938	0.142	0.143	+0.70
Cleveland, Division Ave. Plant†	2.5 ft wide, 6.44 ft deep, 50 ft long; inflow from 7 lateral gutters on $7^1/_2$-ft centers; free overfall; slope = 0	1920	55.6	54.5	−1.98
Cleveland, Baldwin Filtr. Plant†	2.5 ft × 6.2 ft × 50 ft; inflow from 8 lateral gutters on 6-ft centers; free overfall; slope = 0.003	1928	73.6	70.2	−4.62
Mass. Inst. of Tech., exper. channel†	0.75 ft × 1.5 ft × 20 ft; inflow from one side only; level weir crest; free overfall; slope = 0	1937	1.237	1.253	+1.30
San Francisco, Richmond–Sunset Plant	8 troughs; 18 in. × 18 in. × 25 ft; 50 notches 6 in. × $1^1/_4$ in. on 12-in. centers per trough; free overfall; slope = 0.0104	1939	18.2	18.1	−0.55
			16.0	16.2	+1.25
			14.8	14.8	0.00

* From data not used in deriving formula.
† Data from "Lateral Spillway Channels" by Thomas R. Camp, M. Am. Soc. C.E., TRANSACTIONS, Am. Soc. C.E., Vol. 105 (1940), p. 606.

Trends in Power-Plant Space Economy

Balancing Hydraulic Designs Against Structural Details, Plus Conservative Arrangement of Auxiliaries, Effects Substantial Savings

By H. G. Gerdes, M. Am. Soc. C. E.

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Power plants, like other structures, are the product of evolution. Each new plant contains a myriad of apparently satisfactory details copied from previous designs. Frequently, however, careful study may reveal that many of these inherited features can be dropped or modified if a thoroughgoing reintegration of all the plant elements is undertaken. In this paper, which was originally delivered before the Power Division session at the Cincinnati Meeting of the Society, Mr. Gerdes draws attention to specific opportunities for improvement and compares the unit spacing achieved in various existing plants.

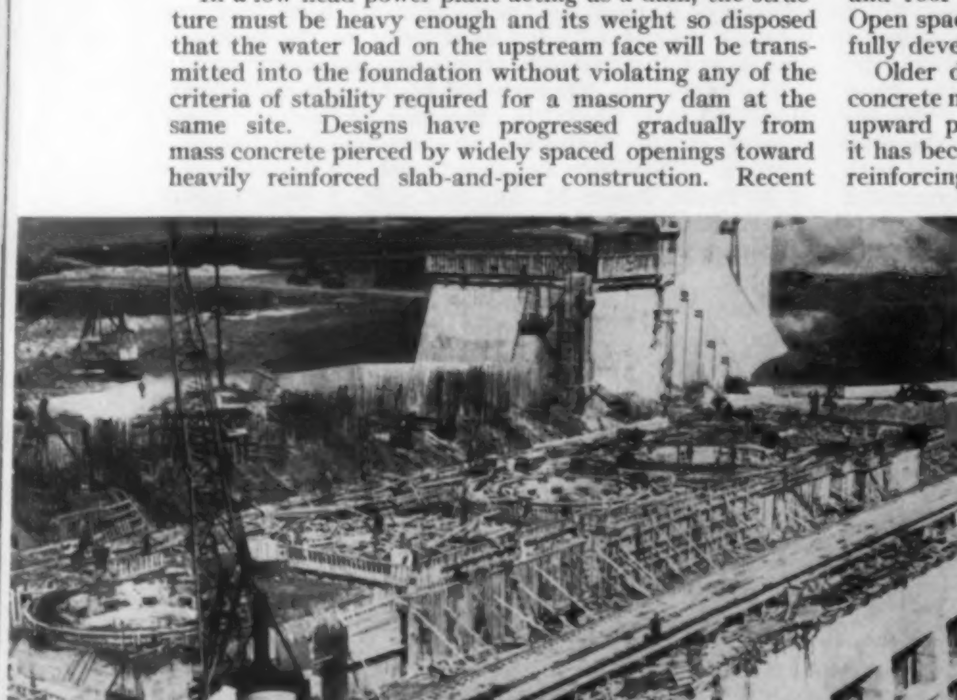
During the period between 1915 and 1930, when hydroelectric plants were largely built by utility companies most of whose income was fixed by regulatory commissions as a percentage of capital invested, economy in construction was often not considered of highest importance and, in retrospect, the many improvements in design of that era were mostly concerned with increased efficiency, greater operating reliability, added comfort, appearance, and the like. During the last ten years, competition between producers of power from all sources has become increasingly severe. New low-interest-rate publicly built hydroelectric plants; improved, highly efficient $80-per-kw steam plants; lower-cost, more reliable "package-power" internal-combustion plants have appeared as competitors of the central station hydro plant. On account of lower costs, there is a tendency for power users to install their own prime movers. All these developments should furnish added incentive for the designers of hydroelectric central-station power plants to use their utmost ingenuity in speeding up the evolution of simplified designs, reducing the number and cost of auxiliary machines, and shrinking the dimensions of plant structure, so that hydroelectric plants still to be built, on sites possessing less natural advantage than those utilized in the past, may be markedly lower in cost and will form both able competitors of, and proper complements to, the modern high-efficiency steam station.

In a low-head power plant acting as a dam, the structure must be heavy enough and its weight so disposed that the water load on the upstream face will be transmitted into the foundation without violating any of the criteria of stability required for a masonry dam at the same site. Designs have progressed gradually from mass concrete pierced by widely spaced openings toward heavily reinforced slab-and-pier construction. Recent structures are fully steel reinforced, although the efficiency in use of concrete as compared with equivalent slab-and-buttress dam sections is still usually far short of ideal reinforced-concrete construction. Many structures have been designed with only the intake section, upstream from the scroll case, included in the portion calculated as a dam. Further progress is being made by shortening intake sections to the hydraulic minimum and utilizing the pier walls between scroll cases as buttress members, carrying structure loads to the foundations through the draft-tube piers, which have not been heavily worked in most existing designs. Sloping headgates, as well as trash racks, may be used to shorten intake bellmouth structures, reducing the concrete structure required around the gates, at the same time that the minimum weight, needed for stability, is reduced by inclining the water load. Many such vertical lines owe their origin solely to the facility with which a T-square and a 90-deg triangle can be manipulated on the designing board!

The structure must act as a conduit under internal hydraulic pressure or vacuum from the forebay through the scroll case, turbine, draft tube, and outlet to tailwater. In earlier designs, the weight of the roof furnished stability. Later structures employed slabs tied to piers, the weight of the whole being considered in balancing the upward force. Recent designs use walls, floor, and roof to resist internal pressure as a box conduit. Open space and drainage are provided under the floor to fully develop the downward pressure.

Older designs generally employed the weight of the concrete masses over and around the scroll case to balance upward pressure. With the advent of larger turbines, it has become the practice to fasten the scroll-case hoop reinforcing to the speed ring at both top and bottom. Various details have been employed and there does not yet appear to be any standard, economical practice. Welding is objected to because of fear of warping the speed ring, and lugs fitted into notches are both cumbersome and costly. At Pinopolis, threaded rods were fastened into holes in the speed ring by nuts, and lapped against the hoop bars.

Placing concrete for the scroll case has advanced from a simple operation of securing a smoothly formed job to a scheduled sequence of pours at even intervals, designed to secure maximum shrinkage before the



Power-House Substructure at Pinopolis Dam, Santee-Cooper Project, South Carolina
Downstream Side Looking Northeast; in Right Background Is 3,000-Ft East Dam; Trucks in Distance Are Completing Fill as Far as Concrete Retaining Wall

closing pours and hence a minimum of subsequent cracking. This process is still in the development state, and the results will not be apparent for some years.

Methods of forming large scroll-case and draft-tube interiors have not advanced materially in two decades in spite of the high cost ($1.50–$3.00 per sq ft) of this high-grade hand-tooled pattern work. Little attempt at re-use of such forms has been observed. In a recent discouraging experience, even after careful planning of operation sequences, the contractor fell behind schedule and wound up by building three duplicate sets of scroll-case and draft-tube forms for 16-ft outlet-diameter turbines.

A considerable variety of concrete scroll-case shapes is found in present practice (Fig. 1), indicating little agreement among designers as to the proper combination of hydraulic and structural efficiency. For a number of years, a rectangular cross section with the speed-ring side open, carrying the water around through about 225°, was in common use. Within the last five years, it has been realized that an appreciable part of the total efficiency of low-head turbines was determined in the scroll.

Hydraulic model work at Bonneville improved the scroll-case design to gain about 3 per cent in turbine efficiency by means of a modified rectangular cross section with rounded corners, carrying the water about 315° around a speed ring, with vanes set to avoid eddies, using an intake experimentally proportioned to give equal flow through three gates. On earlier designs, sometimes as much as 45 per cent of the water entered through the left third of the intake, with consequent uneven distribution of flow to the wheel. At Pinopolis, a scroll of elliptical cross section, approximating a plate-steel scroll in shape, is being used, and the maximum indicated turbine efficiency, predicated from model tests, is over 94 per cent. This shape has permitted the use of scroll-case velocities approximating those used in plate-steel scrolls, thus offsetting the increased space requirement at the same time that efficiency is raised by the better hydraulic shape.

Alining Bushings for Wicket Gate—Pinopolis Power House

In all types of plants, the structure must serve to house and support the machinery and auxiliaries. As the principal support, the concrete structure around the turbine and generator should be so proportioned and reinforced as to provide a rigid support for the rotating mass. It has been thought by some that a rather large mass of concrete around the rotating machinery was necessary in order to avoid objectionable vibration. A figure of 0.5 cu yd of concrete per kilowatt installed has been mentioned in this regard. It does not appear that the minimum mass of concrete actually necessary to properly support the rotating machinery has been reached even in recent structures and it is thought that a properly designed support for the machines will provide all the mass that is necessary. Recent advances in turbine efficiency and in balance give reason for the belief that unbalanced forces tending toward vibration are being diminished by the manufacturers.

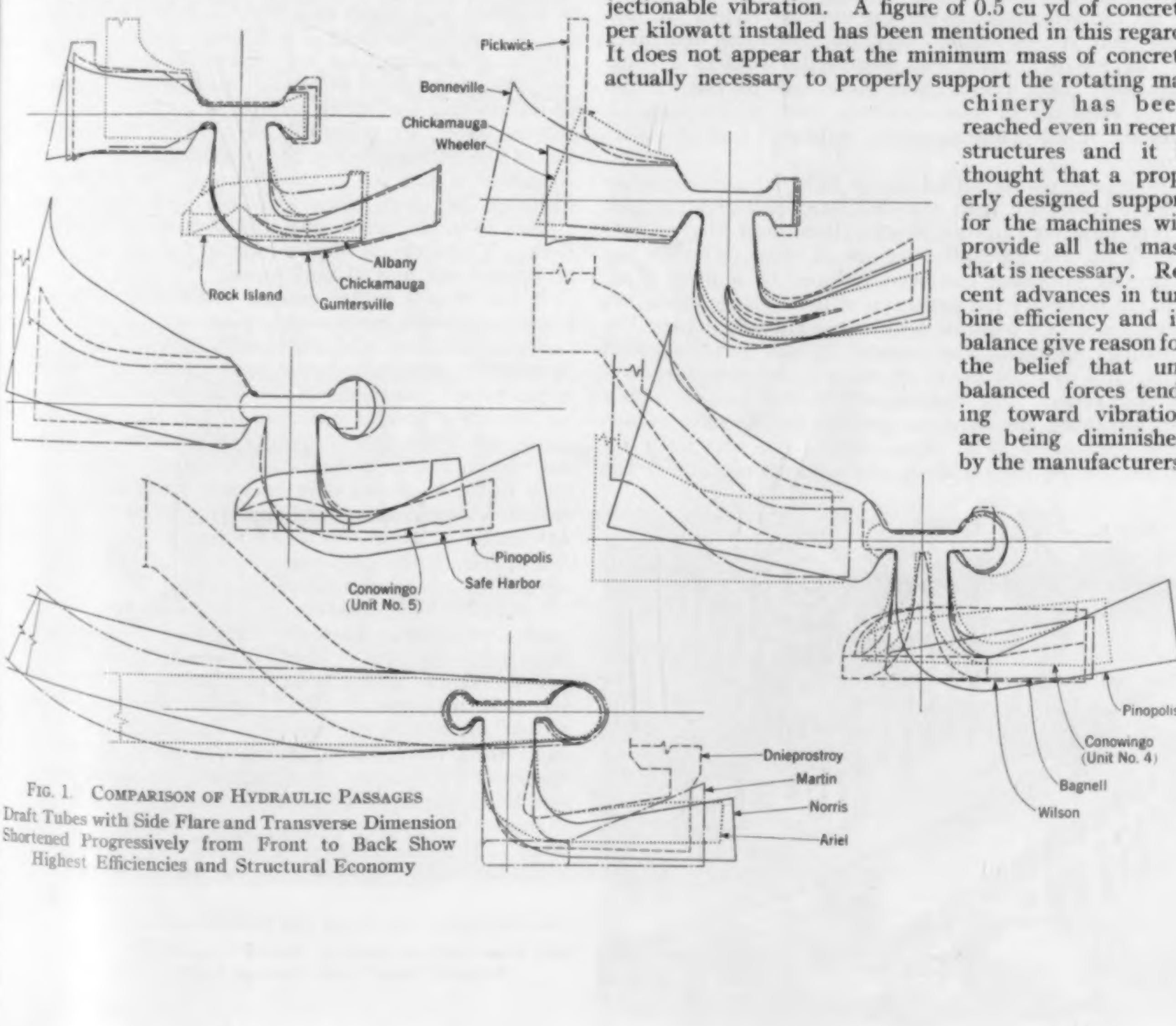


Fig. 1. Comparison of Hydraulic Passages
Draft Tubes with Side Flare and Transverse Dimension Shortened Progressively from Front to Back Show Highest Efficiencies and Structural Economy

One of the most important considerations affecting the economy of the structure is the amount of generator-room floor space provided. On the average, provision in this regard has probably been over-generous and costly. Operating experience should be consulted and the space requirements actually demonstrated over a period of years should be weighed against the cost of doubtful increments to this space, at about $20 per sq ft.

It has been argued that the generator room is all that the "stockholder" or the "taxpayer" (as the case may be) ever sees, and that it therefore should present a pleasing eyeful. Such a view does not appear to be in harmony with sound economics. A good design is pleasing to the eye as a proper expression of its function, and no engineering work need be made disproportionate to be pleasing.

Upstream and downstream aisle space alongside the generators need be no more than sufficient for operating passage. Working space for the extremely infrequent overhauls of the turbine or generator runner should be provided at the end of the generator room. The ceiling height of the generator room must be adequate, if an indoor crane is employed, to allow clearance under the crane or cranes to lift the generator runner and turbine runner at one time and convey them over the adjoining machines to the repair space. This ordinarily requires a comparatively high ceiling and gives rise to one of the larger elements of superstructure cost, which may be avoided by use of the so-called "outdoor" type of superstructure.

Four large plants—Ariel, Osage, Wheeler, and Hiwassee—have been built with so-called outdoor superstructure, a type pioneered by the Electric Bond and Share Company's engineering staff. At one of these, Wheeler, the generator enclosure has been reduced to a mere shell, making necessary the provision of rather large office and work space in a separate building. The others have low buildings enclosing the generators and provided with removable roof hatches to allow operation of an overhead outdoor crane. For stations with no low-tension indoor bus structure, the outdoor type appears to offer important economies. The crane cost is not materially increased, while the building cost is much reduced. The

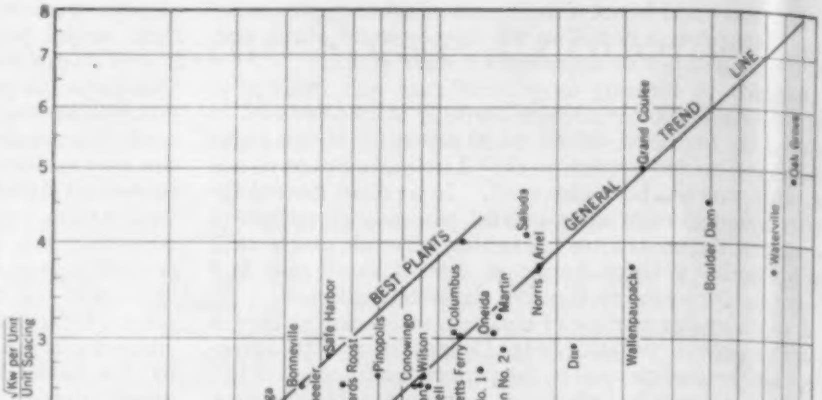


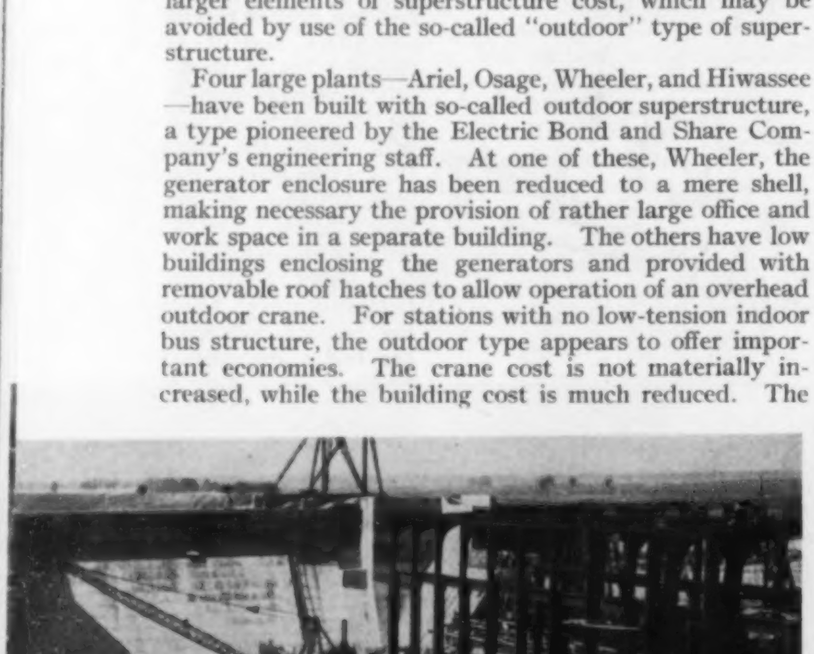
FIG. 2. SPACING OF UNITS IN EXISTING PLANTS

operation of lifting the generator and turbine for repair is very infrequently performed and, with tarpaulins, may even be handled in a heavy rain without injury to insulation.

The unit arrangement of auxiliaries immediately opposite the generating units served has become standard as the most economical position. Such general auxiliaries as unwatering and sump pumps, oil pumps, filters, and storage tanks, are preferably provided at the repair-bay end of the building below the generator-room floor level. Attention is directed in this regard to the possibility of utilizing the space often available immediately downstream from the scroll case and beneath the draft-tube deck. This space is ideally located for pumps, oil filter, air compressor, and oil-tank room.

It has been a rather general practice at large power plants to provide considerable space and equipment for a complete machine and blacksmith shop. This practice apparently arose in the remote California mountains where power plants were at one time required to be self-sufficient for several months. It has been followed in the construction of larger plants much closer to centers of population and complete shop facilities. It is believed that such rather extensive enclosed space and considerable investment in machine tools may be largely reduced or eliminated at plants accessible to commercial shops.

In choosing the size of generating units, the dominant considerations are the capacity that can be conveniently accommodated by the connected system and the available stream flow. From the standpoint of economy, the largest feasible size of individual unit should be chosen because of the saving in size and cost of structure and required auxiliaries. There are also the repeated individual savings in the numbers and lengths of control cable runs, power leads, piping, and all the general auxiliaries of the station. A manufacturing limit in physical size has apparently been reached at around 26-ft runner diameter in a number of recent propeller turbine installations. This limit, to exceed which would require payment for the installation of larger boring mills than those



DOWNSTREAM POWER HOUSE AND NAVIGATION LOCK
View from Top of Concrete Mixer; Top of West Pinopolis Dam Visible Beyond Lock

now available, imposes a practical limitation upon the size of the individual unit in the larger low-head stations. No corresponding limit appears to have been reached in recent medium-head installations, although the size and proportions of the generators installed and ordered at Boulder Dam and Grand Coulee may indicate that a limit for the present maximum generating voltage of 13.8 kv is being approached.

In a multiple-unit station, once the size of the generating unit has been chosen, the greatest single factor affecting the overall cost and economy is the selection of the center-to-center unit spacing (Fig. 2). This dimension should be the least it is possible to contrive. Omission of contraction joints between units will ordinarily permit the spacing to be diminished by from 3 to 5 ft. The shape of the scroll cross section is important in this regard. A scroll of practically rectangular cross section in a large low-head plant will permit unit spacing as much as 6 ft closer than an otherwise similar plant with a scroll of elliptical cross section carrying flow at the same velocity. On the other hand, the increase in efficiency of the generating unit with the elliptical scroll over the other will probably be around 1 per cent. The economic evaluation of this factor is important. For instance, 1 per cent of 30,000 kw at $200 per kw amounts to $60,000 per unit. On the other hand, the cost of the space between units may approximate $8,000 per ft, which multiplied by 6 ft would amount to $48,000 per unit for the difference between the two scroll shapes. On the basis of present information, it is probable that a modified rectangular scroll, with rounded corners, full wrap of 315°, and even intake flow distribution, will permit realization of most of the efficiency possible with the scroll of elliptical cross section, together with the structural savings of closer spacing. This conclusion is conditioned upon adoption of a scroll that will permit velocities as high as those allowed by the manufacturers for an elliptical scroll.

Closer unit spacing not only effects savings in the concrete volume of the substructure and superstructure but also decreases the cost of many other structural features, such as crane rails, parapet walls, conduit, piping, and cable runs.

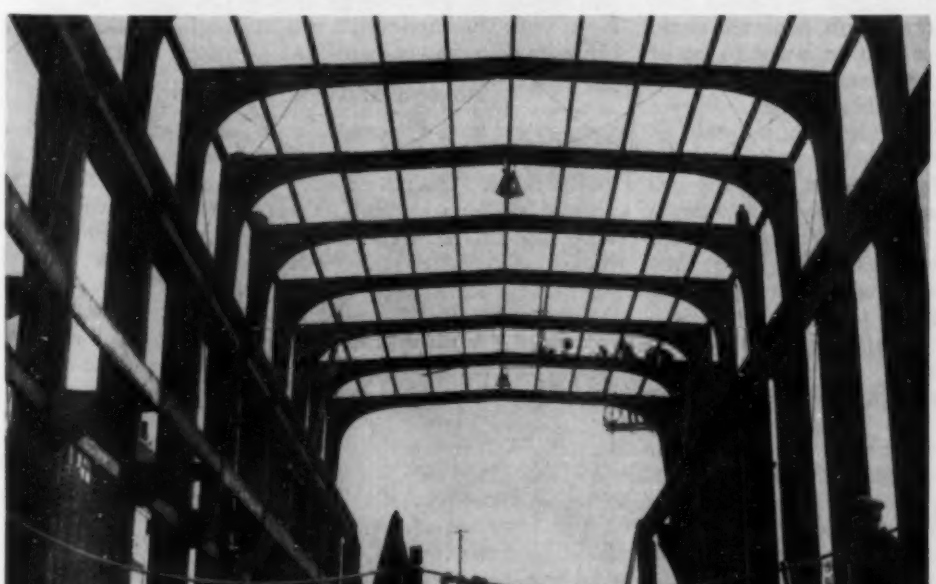
To portray the evolution of thought in design with regard to unit spacing, the diagram (Fig. 2) has been prepared to show the comparative unit spacing of a large number of power plants built during the last thirty years. In order to enable a rational comparison of power plants of different sizes, without weighing the economy naturally accruing to the larger units because of their larger size, the basis of comparison used was the square root of the kilowatt capacity per unit, divided by the unit spacing in feet. This parameter has been plotted against head and permits a general comparison among all power plants in this regard, as well as a much more specific comparison between plants otherwise closely similar. It will be noted that many of the newer plants are considerably better than the average, indicating the increasing attention being paid to closer unit spacing. Some older plants, notably Keokuk, are also considerably better than average. A number of the plants falling below the average line shown are considerably smaller than others of the same head, and their relative position indicates that proportionate unit spacing has not been used in them. Plants of over 200-ft head all fall below the line, indicating that the turbine spacing is proportionately greater.

DERRICKS INSTALL UPSTREAM GATE
Pinopolis Navigation Locks Have 75-Ft Lift —Believed to Be Highest in United States

Examination of the plans for Waterville and Oak Grove indicates that the unit spacing could have approximated that shown by the trend line, by reducing the floor space and rearranging auxiliaries.

Figure 1 shows the variety of intake, scroll case, and draft-tube shapes employed by various designers. All cross sections shown have been projected to the same turbine outlet diameter for comparison. While some of the differences exhibited are due to considerations imposed by the plant site, many of them merely show the idiosyncrasies of their designers and reflect the search for the "best design," which is apparently still some distance ahead of us.

The trend lines in Fig. 2 appear to offer a useful means for checking the probable relative economy of new designs. Of course, there is much more to be said regarding the various power plant features discussed here, and designers will find some points on which they are in disagreement. If, however, the material presented will stimulate further thought and lead to definite progress, its purpose will have been served.



STEELWORK FOR POWER-HOUSE SUPERSTRUCTURE—PINOPOLIS DAM

An Appraisal of Engineering Education

Evaluating the Product in Terms of Present-Day Requirements

By BRUCE D. GREENSHIELDS

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FOR many years both engineers and engineering educators have been examining and appraising formal engineering training. The moot questions in this critique are concerned with how long the training period should be and how much of it should be strictly technical and how much cultural. The answers should be sought in the light of what an engineer is, what he does, and how successful he is.

According to a dictionary definition, an engineer is "one who is skilled in the principles and practice of any branch of mechanical science; as mechanical, electrical, or chemical engineer." Engineering is defined as not only the "science and art of constructing and using machinery, or of designing and constructing buildings, bridges, and roads," but also as "skillful or tactful management." The engineer is thus both a technician and a manager.

Obviously, it is technical skill that enables the recent graduate to achieve his first objective of getting a job so that he can earn his living. Present possibilities are great. The engineer of today enjoys opportunities in a great variety of fields to advance human culture and to make life more purposeful and pleasant. The chances are, however, that the graduate engineer will not even go into engineering work. In a paper read before the Society for the Promotion of Engineering Education in 1936, Dr. Alexander Klemin, of the Guggenheim School of Aeronautics of New York University, stated that 80% of the young men graduating from the colleges of engineering are not in that profession at the end of five years. Furthermore, of those who do go into engineering only about 50% follow the branch they studied in school.

DEFICIENCIES IN RETROSPECT

It is after the engineer has secured a job, achieved some success, and is ready to enjoy life that he is apt to begin to be aware of the cultural deficiencies of his training. With increasing success he has probably progressed from design to management, where all the intangible qualities that go to make up personality are of more importance than technical skill. It is to be expected that the engineer's appraisal of his education will vary according to the job he has been able to get and change with his age and station in life. The young graduate may say that he did not have enough shop work, while the older man is likely to believe that he did not have enough psychology.

The more subjects included in the training course, the longer it must be. Many well-known engineers and engineering educators think it should be more than four years with the liberal arts work preceding the engineering training, while others advocate pre-engineering work integrated with the whole program. It is the writer's opinion that the Greek idea of use courses is the one that appeals to the young high school graduate eager to begin running life's race and that, therefore, technical courses should be given from the first. Even the liberal or appreciation courses, as the Romans thought of them, should be taught as use courses. English is as useful to the engineer as mathematics, and he should be taught to write and to speak it rather than to merely appreciate it.

CONTRASTING INSTITUTIONS

By personal contact I have been able to make first-hand comparison of two schools entirely dissimilar in type and to observe the reaction of graduates to the two kinds of training. One of these schools limits its enrolment to 900 students, the other has many thousands; one is in a small village, the other in our largest city; the students of one come from all over the United States, while the students of the other come from the city only. The larger college charges no tuition; the smaller one does, with the result that its students come from families of higher incomes. The entrance requirements of the larger college are exceptionally high, and its program is more intensive than that of the smaller college.

At Denison University, Granville, Ohio, the training is distinctly liberal. The engineering subjects taught there are of the most general character and widest occurrence in engineering curricula. At the end of four years the student receives a bachelor of arts degree. By that time he has acquired a sufficient number of credits in engineering subjects to enable him to complete his work for a bachelor's degree in engineering at one of the large technical colleges in one or two years, depending upon the branch of engineering followed. On the other hand, at the School of Technology of the College of the City of New York the curriculum is quite similar to that of many other engineering colleges; all the work is specified.

QUESTIONNAIRES SHOW VARYING VIEWS

In so far as it is possible to do so, I will now compare the opinions of the groups of graduates from these two institutions. Questionnaires were sent to 170 of the alumni of Denison, and 100 replies were received. They were sent to 750 of the City College alumni, but only 137 replies were received. From the higher percentage of returns received from the alumni of the smaller college, it is evident that they continue to take more interest in their alma mater after graduation than do the alumni of the larger colleges.

Of the Denison graduates engaged in engineering, 85% found that they needed additional training, while 60% of the City College men felt that they needed more training. Of the Denison graduates, 69% considered their course deficient in so-called non-engineering subjects, such as English, economics, and

IT is almost axiomatic that engineering training should prepare the student as efficiently as possible for his increasing responsibilities in the professional world. In the present article Dr. Greenshields considers the situation in the light of information obtained from the alumni of two widely different types of technical schools. The concrete suggestions obtained in this way for improving college curricula will be of interest to engineers in field practice as well as in teaching.

public speaking, while of the City College graduates 57% found a like deficiency. Apparently neither type of training appears to be adequate for all, and neither is obviously more adequate than the other.

Two-thirds of those graduating from Denison and going on with engineering took additional work at such institutions as Cornell, Columbia, Massachusetts Institute of Technology, Ohio State University, and the University of Wisconsin. Nearly half of the City College graduates took some advanced work—the majority at the School of Technology. Of the graduates of the School of Technology, 75% are engaged in engineering, while two-thirds of this group follow the line of engineering that they studied in school. This is a much higher percentage than for Denison and for the average for all schools. We can conclude that the narrower, more intensive training tends either to confine the interest of the student to engineering or that it does not prepare him so well for other pursuits.

In answer to the question, "As a training for life, what relative importance do you attach to the classroom work and to outside activities?" the majority of Denison graduates replied that they were of equal importance; 24% thought classroom activities should come first, and 12% considered outside activities more important. Since there are far fewer outside activities at City College than at Denison and practically no campus life, it may be concluded the City College student is missing a great deal.

There are other conclusions that can be drawn from the results of the investigations. The fact that 32 out of 33 Denison alumni, who took engineering but did not follow it, found their training the best type for their work indicates the sound principles upon which it is based. The central core of technical subjects, with its four-year sequence, requires the student to retain and to use his previous training. His training is unified and not made up of unrelated subjects that begin and end with each semester, as is true of much of the liberal arts work.

The longer one teaches engineering, the more he realizes that he is teaching a method rather than subject matter. The mental attitude and the method of approach to the solution of problems are of more importance than factual knowledge. On the other hand, however, no one would deny the importance of factual knowledge. The student is judged in large part by his ability to remember facts, and the practicing engineer is likely to think he did not learn enough facts in college.

The replies to the questionnaire sent to City College graduates indicate that each engineer is inclined to see the deficiencies in his training in the light of his own experience. The junior radio engineer finds that he needs

Tall Apartment Buildings form a Background for a Metropolitan College
Corner of C.C.N.Y. Campus in New York, N.Y.

Scene on a Country Campus
Typical View at Denison University, Granville, Ohio

more work in radio communication and mathematics; the electrical draftsman feels the lack of practical drafting, contract estimating, and house wiring; the assistant supervisor of construction finds a need for more training in methods and details of construction; the engineer engaged in flood control work discovers that he needs more training in soil mechanics. The list lengthens hopelessly, and it becomes evident almost immediately that to train the student for all future possibilities would take so long that no time would be left in his life for working.

In a well-balanced scheme of education, as in a well-balanced life, the practical training for earning a living should be combined with the cultural training for enjoying life and association with one's fellow workers. One reply to the questionnaire stated in effect that a liberal education is not acquired by taking a few cultural subjects in the tense atmosphere of the technical college, for "liberal arts" is more than subject-matter. It is a way of thinking and acting and living. It depends upon the intangible values in college life—a leisurely pondering on questions that have always puzzled the human race, and thoughtful consideration of undefined ideas in a youthful striving to express the higher things of life.

The answer to how long the training period of an engineer should be and what the balance of subjects should be in that period is not clear-cut. The purpose of engineering training, if one is to judge by what engineers do, is almost as broad as life itself. With a purpose so broad, it is not logical to expect any one type of training to be the sole answer. All who work at engineering cannot be leaders. Some must follow. Some are more capable than others; some are more ambitious. For those who are to remain technicians, and possibly for the majority of others, the four-year training period is probably long enough. And if one is to judge by what the employers of private companies want in graduates, that four-year period need not be too technical. Almost without exception, the "B" student with outside activities to his credit is picked in preference to the "A" bookworm who has sacrificed the more abundant student life for the sake of higher grades.

However, the great majority of leaders do advocate the longer and more liberal training period for the student who gives promise of becoming a leader himself. In certain cases its value seems clearly indicated, and the program of training should be shaped according to the end in view. It may well be that for those who hope to reach the top, the more thorough training is desirable, if not essential.

New Orleans Bridge Foundations

Experiences with a Major Structure Having Deep Piers on Fine Sand

By Frank M. Masters, M. Am. Soc. C.E.

Consulting Engineer, Modjeski and Masters, Harrisburg, Pa.

Founding a large structure on fine sand, even at great depth, always raises questions in the engineer's mind. Answers to two persistent uncertainties are given here: (1) sinking the piers was not easy and there were blow-ins, a few of them serious; and (2) in succeeding years some settlement has been experienced, but of moderate amount, as anticipated. Of particular interest are Mr. Masters' comments on side friction of caissons and piers, as it affected this successful foundation construction.

Since the opening of the New Orleans Bridge, several papers have been published relating to the settlement and movement of its piers, which are founded at great depth in the delta deposits of the Mississippi River. A recital of some of the experiences during construction may have an interesting bearing upon the settlement studies.

In the first design for a bridge at New Orleans, made in 1892, open-well caissons were contemplated because the depths of foundations were too great for compressed air. Although this early design was not built, it had an influence on all later plans.

In 1918, studies for both a bridge and a tunnel were prepared by a board of prominent engineers. Wash borings made at that time seemed to point to the necessity of carrying piers as far as 225 or 250 ft below Gulf level by open dredging in order to found them in what was indicated to be "an excellent foundation of coarse sand." These piers were designed for a net additional pressure of 4 tons per sq ft on the pier bases, after first allowing for an effective side friction of 400 lb per sq ft. The recommendation of this board was for a low-level bridge.

In 1926, additional wash borings were taken with better equipment, some carried to a depth of −600 ft (Gulf datum). They revealed a heavy clay stratum at about El. −270 ft. This stratum, however, can have practically no effect on piers founded on the good sand above. Samples taken from these borings, although disturbed, were analyzed by remolding the clays to approximate their undisturbed condition. These analyses indicated the necessity of founding the large main river piers at 165 ft or 170 ft below mean Gulf level in a stratum of fine sand, thus avoiding placing the foundation loads directly upon any stratum of the compressible clay, locally called "gumbo."

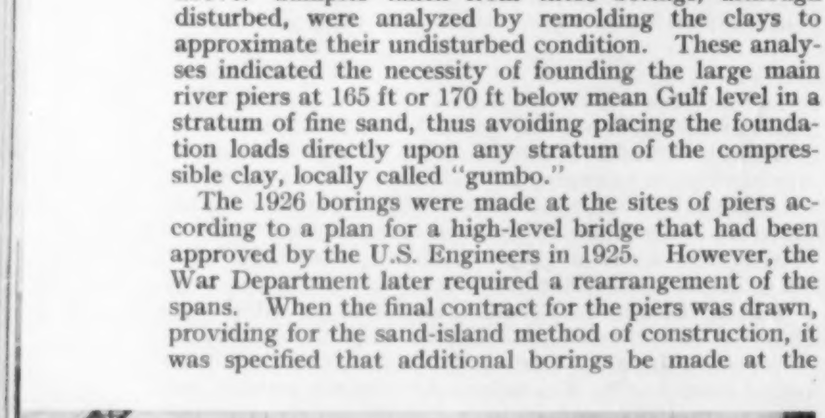
The 1926 borings were made at the sites of piers according to a plan for a high-level bridge that had been approved by the U.S. Engineers in 1925. However, the War Department later required a rearrangement of the spans. When the final contract for the piers was drawn, providing for the sand-island method of construction, it was specified that additional borings be made at the corners of each new pier and that undisturbed samples be recovered.

Subsequently final borings were made using an oil-well drilling method in sinking the casings, rotating them on a driller's turntable, and sinking the ones of smaller diameter to great depths inside the top 10-in. casing with the assistance of a clay-water lubricating mixture. The undisturbed samples, taken with a special bit under our supervision, were analyzed. The correlation of strata across the river based on these data was very difficult. While the soil profile, Fig. 1, is based upon both these borings and the dredging records, it is necessarily generalized, for many minor discrepancies are inevitable. The later dredging operations within the piers substantially checked the borings, but also revealed that such sampling cannot give a perfect picture of conditions.

When the soil analyses were completed, predictions were made, as shown in Table I, on the expected settlements of the piers over a long period of time. It was desirable to make prior allowance for those settlements in order to maintain a smooth, even profile in the completed structure. Accordingly it was agreed that the pier tops should be finished at an elevation higher than the plan elevation by an amount more than sufficient to allow for the pier settlement that was predicted to occur between the time of finishing the pier tops and opening the bridge. Then, when the bridge was opened, the deck would be slightly higher than the design profile. This plan was followed; and in December 1940, 5 years after opening, the bridge seat elevations were above or below the original plan elevations by the following amounts: Pier 1, $^3/_4$ in. above; Pier 2, at plan elevation; Pier 3, $^3/_4$ in. below; Pier 4, $1^1/_2$ in. below; Pier 5, at plan elevation. Since the settlement to be anticipated in future is negligible, the safety and integrity of the structure remain unquestioned.

The main piers were sunk to the desired elevation by open dredging the caissons through sand islands. The records that were kept of the materials removed during these operations substantially checked the contract borings. It had been early determined that it would be desirable to have all piers founded in the fine sand stratum below the second gumbo stratum. This clay or gumbo, when dropped from the dredge buckets, fractured into large pieces and was very difficult to excavate. When dried in the sun it had the appearance of fine-grained white sandstone.

In the actual construction, as indicated on the profile, Fig. 1, all piers were carried through this clay stratum into the good compact sand below. At each pier careful soundings, as well as diver examinations, were made to be sure that the clay had been penetrated over all the area before any sealing operations were undertaken. Hence it is believed that there is no clay stratum beneath any of the piers that should be considered in connection



Setting Forms on Cutting Edge Resting on Sand-Island Fill, Pier 4

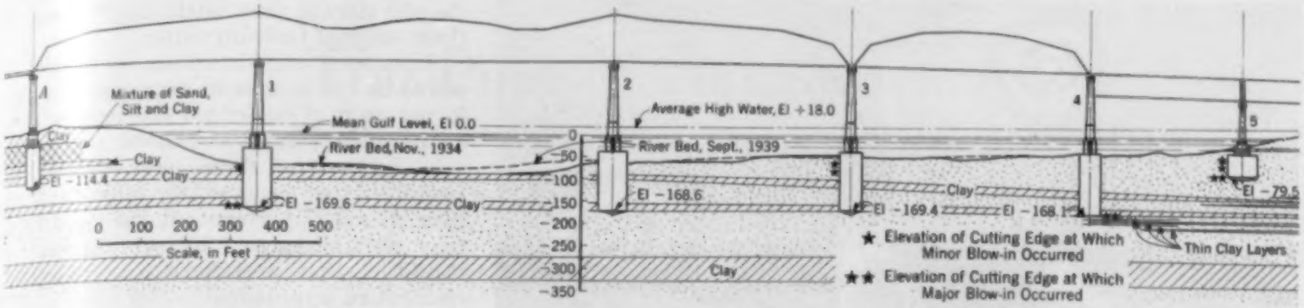


Fig. 1. Generalized Soil Profile, Looking North, Based on Borings and Construction Records

with the settlement studies except the thick stratum indicated by the borings to exist 100 ft below the piers.

After the final clay stratum had been penetrated and the pier was ready for sealing, it was found that the last dredging below the cutting edges could not be accomplished until all sinking and dredging operations had been suspended for a number of days, to allow time for the caisson to "freeze" fast, through an increase in skin friction. It would then be possible to remove the materials from beneath the intermediate walls of the chamber down to and below the exterior cutting edges. However, this operation had to be carried out very carefully to prevent a "blow-in" or sudden inrush of the sand, as will be shown from the accompanying brief descriptions of experience in sealing each of the piers. Some minor blow-ins occurred during sinking, as noted in Fig. 1. An account of the problems encountered at the founding elevations in sealing each of the piers will give some idea of the difficulty of relating theory to practice in any soil mechanics study. Some of the settlements that have since occurred are probably due to disturbed conditions on the bottom produced by these blow-ins.

Table I. Pier Settlement Predictions, July 1933

Pier	Load (Tons per Sq Ft) Total D.L. +20% L.L.	Consolidation of Sand	Consolidation of Clay	Predicted Settlements, in Inches: Total Due to Consolidation Under Pier and Bridge Loads	After Placing Bridge Seat	After Opening of Bridge	First Five Years 1935–1940	Second Five Years 1940–1945	Next Ten Years 1945–1955
A	6.22	1 1/2	1 3/4	3 1/4	2	1	3/4	..	1/4
1	6.19	2 1/2	3	5 1/2	3 3/4	1 3/4	1/4	1/4	1/4
2	6.19	1 1/2	4	5 1/2	3 1/4	1 1/2	3/4	1/4	1/4
3	6.08	1	1 1/4	2 1/4	1 1/2	1	1/2	..	1/4
4	6.00	3/4	1 1/4	2	1 1/4	1/2	1/4	..	1/4
5	2.78	3/4	1/2	1 1/4	1 1/4	1/4	1/4	..	..
B	1.02	1	3 3/4	4 3/4	4 1/4	3/4	3/4	..	..
C	1.00	1	3 3/4	4 3/4	4 1/2	1 3/4	1 1/2	1/4	..
D	0.93	1/2	4 1/4	4 3/4	4 1/2	2 3/4	2	1/2	1/4

Pier A, constructed in the dry behind the west bank levee, was open-dredged to its final elevation without any blow-ins or unusual difficulties.

Pier 1 was sunk satisfactorily until it had penetrated the second of the two clay strata. When the final elevation of −169.6 was reached, only the center nine wells could be dredged. Jetting was used to secure a final penetration below the clay stratum. After the center nine wells were sealed, the three wells at each end were cleaned out one at a time to a point below the cutting edge.

Attempts to clean these end wells simultaneously below the cutting edge resulted in a blow-in that carried about 4,000 cu yd of fine sandy materials up into the downstream wells. From here it was transported in suspension through the caisson equalizing holes, and buried the entire seal concrete to a depth of 30 to 40 ft above the cutting edge. Soundings outside the caisson indicated that this material had been drawn principally from the downstream area between the sand-island shell and the caisson, where the volume of the depression in the bottom of the river closely approximated the volume of material that actually flowed into the caisson.

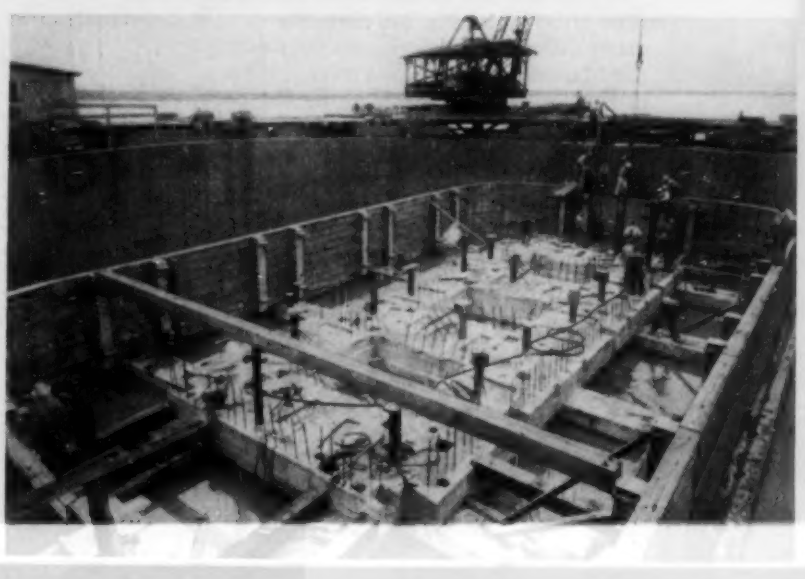
Pier 2 was sealed without any particular difficulty except that the caisson "hung up" on the second clay stratum, and had to be freed with the aid of small charges of dynamite. There were no blow-ins.

Pier 3 was also sealed at its final elevation without any unusual difficulty.

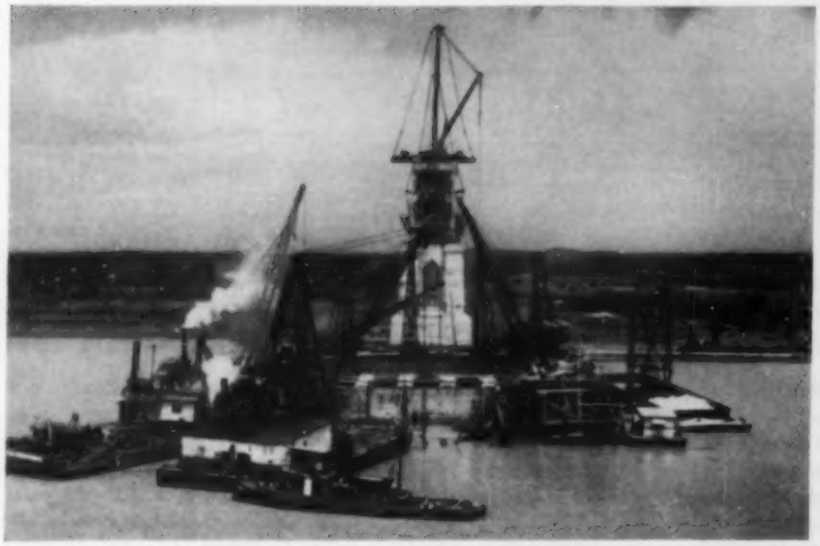
Pier 4 was sunk with little trouble until it reached the second clay stratum, where, with the cutting edge at El. −165, the caisson was apparently bound by skin friction, for it failed to respond to further dredging. In attempts to move it, the three center wells were dredged to a depth of about 9 ft below the outside cutting edge. The material removed was a mixture of sand and clay. Since this pier failed to respond to further dredging operations, the contractor was of the opinion that the intermediate walls might be supported on clay, and to break down this material if present, he resorted to the firing of small charges of dynamite individually in the three center wells. However, careful soundings indicated that the dredging, which was carried below the cutting edge, was producing only good sandy materials.

The dynamite shots caused the caisson to drop about 3 ft to cutting edge El. −167.9, and were accompanied by a blow-in. About 8,000 cu yd of fine sandy material moved up into the caisson, rising about 66 ft above the cutting edge. The caisson was equipped with a 50-ft-high cofferdam required to build the distributing block and pier shaft on top of the caisson. The blow-in forced water out of the caisson and up into the cofferdam, creating a hydrostatic head that blew the cofferdam into the river and destroyed portions of the sand island.

Soundings indicated that the material had entered the caisson from the river side. The volume of the depressed



Erecting Cofferdam Within Sand-Island Shell, Pier 4



SCENE OF DAMAGE FOLLOWING BLOW-IN, PIER 4

area in the river bottom approximated closely the computed volume of the material that had blown in. This caisson was finally sealed in good compact sand at cutting edge El. −168.1. However, the foundation materials had been so disturbed during the blow-in that the dredging wells had to be excavated and sealed individually, and it was not possible to carry the seal below the exterior cutting edges.

Pier 5 was sunk with little difficulty, except for two minor blow-ins, until the cutting edge reached El. −79.3, when a major blow-in occurred at the downstream end while dredging was under way. At this time the wells had been dredged from 2 to 6 ft below the outer cutting edge and the sand island had been excavated to about normal river bed level, El. −20. About 800 cu yd of fine sand moved into the caisson, filling the dredging wells from 5 to 10 ft above the cutting edge. The river bed showed a depression outside the downstream cutting edge indicating that the material had flowed in from there. This caisson was finally cleaned and sealed in good sand, after dredging had been carried about 5 ft below the center cross walls.

Besides such disturbances in the condition of the bottom, a source of uncertainty in making settlement predictions is a proper evaluation of the share of the total load carried by skin friction. No skin friction was counted upon in the design of these piers, or in the calculations of their settlements. At the time Pier 4 refused to respond to dredging, the indicated dead weight was exerting a force to overcome skin friction of approximately 620 lb per sq ft of embedded caisson surface; and since the caisson was hung up, the skin friction must have been at least equal to this.

We have made similar determinations of the amount of skin friction acting on caissons during construction in many different locations, not only along the Mississippi and Ohio rivers, but also in the Lake regions and along the Far Western coast, where the indicated skin friction, while varying with the materials encountered, has always increased for a short time when a caisson has been allowed to rest in the soil. It is probable, however, that after the pier is sealed, the gradual consolidation of surrounding soils under their own weight may, by their friction on the pier sides as they settle, slightly reduce these original built-up values.

From such considerations, we believe it would be fair to assume approximately 450 lb per sq ft of embedded side caisson area as the average final value of the supporting skin friction on these piers. Table II, based on this assumption, indicates that from 17 to 27 per cent of the dead load may well be carried by skin friction—a condition that introduces a considerable element of approximation into any settlement predictions.

As a matter of interest we have endeavored to maintain a series of continuous readings indicating the relative movements of the piers in the completed New Orleans Bridge. In order to relate such movements to cutting-edge elevations, the benches were frequently transferred during construction and this may have introduced errors of uncertain amount in the readings on account of shrinkage of pier concrete, elastic shortening of the piers under load, and similar factors. The Public Belt Railroad Commission has taken these levels at intervals ever since, together with frequent soundings of the river bottom, in connection with our firm's continuing obligation for the supervision of the structure. It is these levels and soundings that have formed the basis for the many discussions of the settlement of the bridge.

In connection with these readings, it has been noted that there is an apparent relative change in elevation of the piers with changes in water elevations, the piers appearing to rise as the water level goes down and vice versa. We have recorded similar changes in the elevation of deep piers with changes in water elevation on other structures constructed in like materials. The approach structures of the New Orleans Bridge are the reference benches to which these main pier levels are run, and since the ground on each side of the river is of the same general low-lying character, there is no nearby permanent bench to which all readings can be referred. At the site of the recently constructed Baton Rouge Bridge, on the other hand, there is a permanent high clay bank at the east end of the structure, and at the west end, delta materials similar to those at New Orleans.

The bridge engineers of the Louisiana State Highway Department are making a series of settlement observations on the piers of this Baton Rouge structure in such a way that the readings can be referenced to the permanent clay bank on one side and to the delta materials on the other. These records, when completed, may finally determine whether or not this peculiar and unusual phenomenon occurs in the benches, the main river piers, or the approach structures. However, whatever movements have been detected in the New Orleans Bridge or in similar structures in the delta lands are so minor in nature as not to reflect in any way upon their integrity.

TABLE II. PIER LOADS, DIMENSIONS, AND SKIN FRICTION, NEW ORLEANS BRIDGE

Pier	Loads: D.L. (Kips)	Loads: L.L. for E-90† (Kips)	Base Area (Sq ft)	Gross D.L. Pressure (Tons per Sq Ft)	Embedded Depth of Caisson (Ft)	Net Addl. D.L. Pressure (Tons per Sq Ft)	Periphery, Caisson (Ft)	Embedded Side Surface, Caisson (Sq Ft)	Supporting Skin Friction* (Kips)
A	37,712	4,970	2,998	6.3	100	2.8	220	22,000	9,900
1	80,335	11,016	6,437	6.3	99	2.8	305	30,190	13,585
2	80,335	11,016	6,437	6.3	106	2.6	305	32,330	14,549
3	58,798	8,164	4,846	6.1	122	1.9	268	32,696	14,713
4	58,078	6,774	4,846	6.0	131	1.4	268	35,108	15,799
5	27,374	4,912	5,550	2.5	45	1.0	277	12,465	5,609

* At 450 lb per sq ft average (not counted upon in design).
† Operating loading, E-65.

The Port of Baltimore

Great Industries Centered at Inland Seaport Where Society's Spring Meeting Will Be Held

By F. M. KIPP, JR., ASSOC. M. AM. SOC. C.E.
HARBOR ENGINEER, DEPARTMENT OF PUBLIC WORKS, BALTIMORE, MD.

BALTIMORE is a seaport located inland 170 miles from the ocean. It is situated on the Patapsco River near the head of the magnificent Chesapeake Bay. Baltimore Harbor, which is $12^1/_2$ miles from the bay, includes 40 miles of waterfront along the river and its tributaries.

A thriving commercial and industrial center, Baltimore is closer than any other northern port to the great industrial producing and consuming territory of the Middle West and to the center of population of the United States. Nearly 63,000,000 people, or about half the total population of the country, live within overnight rail service of Baltimore.

The navigable tidal estuary extends into four principal arms or branches (Fig. 1), known as the Northwest, Middle, and Main branches, and Curtis Bay.

The Northwest Branch, which constitutes the inner harbor and lies inside of Fort McHenry and Lazaretto Point, penetrates to the center of the city for a distance of 3 miles with a width of from 800 to 3,000 ft. Within this area are the terminals of the Baltimore and Ohio Railroad and the Pennsylvania Railroad, together with the municipal docks, which are located along Pratt Street. Many large industries that require deep water facilities are likewise located within this area.

The Middle Branch, also known as Spring Gardens, extends about 2 miles from Ferry Bar to the foot of Eutaw Street, and has a width of from 1,200 to 2,500 ft. Dock development within this area has been retarded because two drawbridges obstruct the Branch. However, numerous industrial plants, both large and small, have located here.

Extensive industrial development is also found along the Main Branch of the river for a distance of about 5 miles. On the north shore there are two railroad terminals and the Municipal Airport, while numerous fertilizer and oil companies are located along the south shore.

The Curtis Bay area, which lies south of the Patapsco River, is about $1^1/_2$ miles long and approximately three-quarters of a mile wide. This is a highly developed section, as is Sparrows Point, directly opposite the Curtis Bay area.

There are other branches of the Patapsco River, which have not been commercially developed as yet, and are now used as summer residential areas.

At one time entrance to the port was limited to the Virginia Capes, but since the deepening of the Chesapeake and Delaware Canal, an alternate route, which saves considerable mileage to northern and European ports, is available. In fact, the use of this route reduces the distance to the Atlantic to 128 miles. The canal is toll free and has a working depth of 27 ft.

SOME ADVANTAGES OF THE PORT

Few ports have the advantage of the small tidal fluctuation that exists at the Port of Baltimore. The average change is only 1.2 ft, and this condition is extremely helpful in the construction of port facilities. The port facilities also benefit from the absence of the teredo, a circumstance which has permitted the use of untreated timber at a great saving in cost.

Because of its geographical location, the port has the added advantage of freight rates on export and import traffic to and from the interior, lower than those in effect for New York, Philadelphia, or Boston. The differential, established by the trunk line railroads over 50 years ago, is still in effect.

The four railroads that enter Baltimore have developed deep water terminals, which afford car-to-ship transfer for export and import, thus facilitating the handling of freight at minimum cost.

On the average 4,000 ships visit the port annually. Of these, 1,300 are in foreign trade, 300 in intercoastal, and 2,400 in coastwise. During 1939 an aggregate of 23,600,000 tons of cargo was handled. According to official statistics for 1938, Baltimore is the second United States port in volume of imports and fourth in total of foreign trade tonnage. It is the first Atlantic and Gulf port in volume of west-bound intercoastal tonnage.

It is important to note that in this whole vast area along the Patapsco River, neither the City of Baltimore nor the State of Maryland has built a port with its own funds. Private interests have been responsible for the entire de-

THE PORT OF BALTIMORE AS IT LOOKED IN 1939

velopment, from which the city reaps the greater benefits. However, the city is prepared to advance money to private interests to improve the water area. In 1920 the City of Baltimore was authorized to issue \$50,000,000 in stock for the purpose of developing, expanding, and improving the harbor and its facilities. This loan, known as the Port Development Loan, is supervised by the Port Development Commission, which comprises a board of five members appointed by the mayor and includes the mayor and chief engineer, ex officio.

Under the provisions of the Port Development Loan the most important stipulation for the expenditure of money is that the Port Development Commission must have bona-fide leasing contracts, which will amortize that portion of the loan expended. These must specify a definite rental time. In financing municipal improvements beneficial to private interests, one of the most important considerations is to avoid placing the burden on the taxpayer. Elsewhere port facilities such as these are generally financed through the taxpayer.

Discharging Cargo at Pennsylvania Railroad Pier
Scene Typical of General Waterfront Activity

There is no "Port Authority" at Baltimore. The Bureau of Harbors, which is in the Department of Public Works, handles all engineering work in which the municipality takes a part. All promotional advertising and business soliciting for the port are delegated to the Export and Import Bureau of the Association of Commerce. In this way the work of the usual "Port Authority" is divided.

The Bureau of Harbors has under its jurisdiction the control, operation, and maintenance of all drawbridges. It supervises and passes upon all improvements by the issuance of permits. It maintains the necessary forces for making repairs on city-owned piers used entirely for coastwise and bay traffic.

During severe winters some difficulties are experienced with ice in the bay area. Ice boats are maintained jointly by the city and the state, but the Bureau of Harbors is responsible for their operation. The new Municipal Airport described in the October 1940 issue of PROCEEDINGS), which was constructed in the waters of the Patapsco, was under the supervision of the Bureau of Harbors until the area had been filled. Its completion is now supervised by the chief engineer and a consultant, under whom several public works bureaus are cooperating.

Although the federal government maintains the channels up to Fort McHenry and to the Hanover Street Drawbridge in the Main Branch, the areas above this are maintained by the city. All dredging operations and improvements in these city-maintained areas are among the other duties of the Bureau of Harbors. For the benefit of shipping, the Bureau maintains and operates municipal radio station WMH. This service, in connection with the Radiomarine Corporation, handles all port radio business.

The Port of Baltimore has approximately \$151,000,000 invested in channels, steamship piers, terminals, warehouses, and miscellaneous port facilities and equipment. Over 14,000 persons are directly and indirectly employed. Direct port revenues to the city from shipping, which include such services as pilotage, towage, pier rentals, stevedoring, and repairs, total more than \$20,000,000 a year.

Fig. 1. Many Inlets Provide Long Shore Line and Extensive Terminal Facilities for Ocean-Going Vessels at Baltimore

Applications of Soil Mechanics in the Heavy Construction Industry

By Jacob Feld, M. Am. Soc. C.E.
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From its early beginnings, the heavy construction industry has developed the art of dealing with soils. Trial and error over a long period of time have resulted in the building up of a body of practical knowledge as to safe methods, although these methods generally cannot be checked by theoretical design computations. Dr. Feld does not attempt to treat the design of permanent structures involving the application of soil mechanics, but discusses only temporary structures and methods used as construction expedients. The paper from which this material was abstracted was originally presented at the S.P.E.E. Soil Mechanics Conference held at Purdue University last September.

Often trade practice is determined by the availability of usable tables or formulas for design. It is my purpose to present here some comments regarding information available on various foundation construction problems, as an invitation to further studies.

Construction roads over very soft ground, such as salt marshes, are normally made by depositing a layer of sand fill 3 ft thick. This fill settles 2 ft and forms a good road a foot above marsh level, without forming any mud waves. The addition of a load of 300 lb per sq ft on a width of 15 to 20 ft consolidates the soft muck sufficiently to permit transportation of heavy loaded trucks (25 tons on six wheels with 85 per cent on the rear axle with four pneumatic tires). Such a road served with practically no maintenance for two years in a tidal marsh that would barely carry a man's weight and into which a 12-ft length of 1-in. pipe could be pushed by hand to its full length. In a similar area, a 2-ft sand layer was found insufficient. The action may be partly explained by assuming that the soft muck interlocks the sand grains and develops a new material, which forms a floating, semi-rigid, and dense mat.

Hauling over new fills, especially hydraulic sand fills, has resulted in the development of a very cheap trackage procedure. Rolls of wire mesh, 2 to 3 ft wide, with 2 by 2-in. openings of the type used for chain link fences, are laid out to form runways for truck wheels. Fully loaded trucks (6-cu yd level measure, or 5-cu yd transit-mix concrete trucks) can then be run over ground that would not hold a light car. The mesh is preferable to solid plates because it eliminates slipping and also is more economical. Under use, it becomes buried but can be lifted out of the fill by crane or by hand. Careful analysis and tests of this method will result in the solution of a difficulty encountered on many construction jobs.

Narrow trenches, such as those for sewers, show no consistent practice in the design of sheeting and bracing, as the usual "feel" of the contractor is that the type of protection used in large excavations of similar depth is too expensive and not warranted. It is surprising how little bracing is normally necessary, but of course such trenches are open for only a few days. Recently, two similar accidents which may be of interest occurred in the New York area. In removing old brick sewers, excavation was carried down to the sewer in an unsheathed trench. However, when a section of the brick arch was cut, the side banks suddenly collapsed. This seems to contradict some recent theories that such excavations will be safe, if held near the top, and that no pressure exists near the bottom of the excavation.

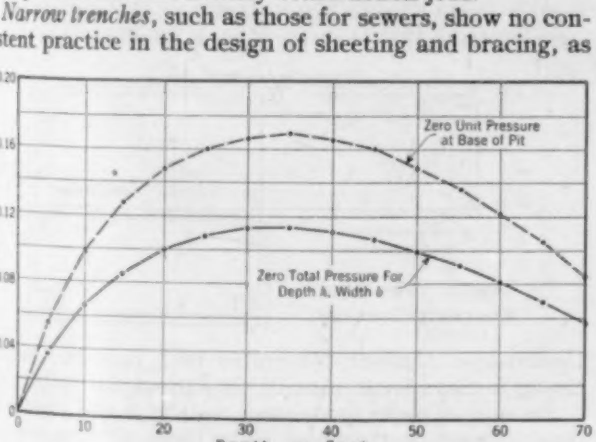


Fig. 1. Lateral Pressure in Pits

Underpinning operations for buildings have become well standardized. Where continuous wall underpinning is desired, the procedure is to sink pits 4 to 5 ft in width, undermining that length of the foundation, construct the new concrete wall for that length, skip a similar distance, and repeat the operation. The intermediate lengths are then taken care of in a later sequence. For sheathing horizontally in the pits, 2-in. planks (sometimes 3-in. for depths below 20 ft) are customarily used. Such boards would not sustain the lateral earth pressure unless a correction to the usual formula were in order. (See the writer's paper in Transactions Am. Soc. C.E., Vol. 86, 1923, page 1580.)

Vertical Soldier Beams Resting on Horizontal Girder Take Lateral Thrust from Cut Bank

Girder Span Is 50 Ft Over Two-Track Tunnel, Which Is Below Subgrade of Excavation Shown. Vertical "Dead Men" at Ends of Girder Are Concreted Into Pits Outside of Tunnels. Soldier Beams Have 30-Ft Vertical Span

The reasonable assumption for evaluating earth pressure acting on one side of a pit, with the adjacent soil held in position by either undisturbed soil or concrete poured inside closely fitting sheeting, is that the effect of the

PRE-CAST CONCRETE SHEETING ONLY $1^1/_2$ IN. THICK USED ON 5-FT SPAN IN UNDERPINNING PIT

Projecting Wire Loops Distinguish Inside Face of Sheeting and Also Serve as Hangers While Cutting Below Last Sheet for Clearance Needed for Next Sheet Down

wedge of rupture must be reduced by the frictional resistance of the earth on each side of the wedge. For simplification, the wedge is assumed as triangular, and the resistance is to horizontal motion of the wedge. For a width b and depth h, the total pressure on a side of the pit is:

$$\tfrac{1}{2}wh^2 \tan^2 \tfrac{1}{2}(90° - \phi) \times [b - \tfrac{2}{3}h \tan \phi \tan \tfrac{1}{2}(90° - \phi) \sin \tfrac{1}{2}(90° - \phi)]$$

The diagram (Fig. 1) shows for what ratios of b to h the total pressure and the unit base pressure on a pit side are zero, although there is pressure near the top which must be taken care of. For usual soils, there is no horizontal pressure at the base of a pit 6 times the width or more in depth.

Based on this theory, pit boards of light-weight concrete $1^1/_2$ in. thick were pre-cast for use in pits $4^1/_2$ and 5 ft wide and were successfully used to depths exceeding 25 ft in various soils, including dense clays, small boulders, and rotten mica schist, with the water level about 12 ft down. These slabs were 8 in. wide, and shaped with a reinforced half-joint detail to allow for ease in connecting them (see Fig. 2). In the laboratory they showed cracks at an equivalent loading of 260 lb per sq ft when tested on a span of 44 in. Similar use has also been made of pressed steel sheets of the same strength as the concrete boards designed by the writer in 1936.

Prediction of building settlements with known loadings and soil conditions becomes important when additions are constructed to buildings already permanently set after years of loading. A typical example is the addition of a new unit to a 7-story warehouse resting on sand, where the owners desired to match the exterior ornamental stone details. The writer ordered the new structure built $^3/_4$ in. higher than the existing one to allow for settlement, and upon completion a perfect match of exterior details as well as floor levels resulted. In another example, the writer was asked to investigate the reason for cracks appearing in a similar extension job and it was easily determined that the settlement under loading of the additional unit had dragged down parts of the older building. (No clear-cut separation had been provided.)

Settlement from vibrations caused by construction equipment, such as hoists, compressors, and engines, as well as transfer of vibrations to nearby structures, can only be avoided by special care in the design of supporting foundations. The problem becomes especially serious in planning construction equipment for contracts such as subway construction in heavily populated cities. Not only is there danger of equipment failure, but there is also the monetary loss from claims of alleged damage to neighboring properties.

On one contract for the New York Sixth Avenue Subway, the writer, after investigating all the commercially produced vibration dampers, could not recommend any of them for eliminating vibration transference from three horizontal mounted air-compressors. The machines were placed on top of a rigid reinforced concrete rectangular tube, the base resting on a 3-in. cork layer, and the sides separated from the building walls by a 2-in. air gap. The air receivers and coolers were placed inside the tube, and the air supply line left the building in a flexible metal hose. By actual vibrograph readings, in the building, the four-cycle vibration of these machines was damped 95 per cent. There was no perceptible transfer to the street. These same machines had been used on a previous contract and were there mounted on concrete bases 6 ft deep in wet sand. In that location, the vibration could be detected without instruments for a distance of over 100 ft in any direction.

A BUILDING FOUNDED ON SPREAD FOOTINGS (LEFT), WHEN IN CLOSE CONTACT WITH ONE FOUNDED ON ROCK (RIGHT), MAY HANG ON TO LATTER AND TEAR AWAY

Continuous vibration cannot be eliminated by any special type of foundations. Only air gaps or cork and rubber dampers will solve the problem.

Unprotected cored shafts are becoming common practice and little is known of the limitations under which such shafts can be safely used without affecting adjacent ground volumes. In the wet-caisson rotary-drill method, the excavated shaft is kept full of water to "prevent ground loss" (used in Illinois Motorists Association Building in Chicago to 65-ft depths). In the dry caisson rotary drills, using a revolving reamer for cutting and removing excavation, no water is admitted and lagging is placed after the completion of the excavation (used in Detroit Post Office to 120-ft depths). A description and comparison of these two methods is found in an article in

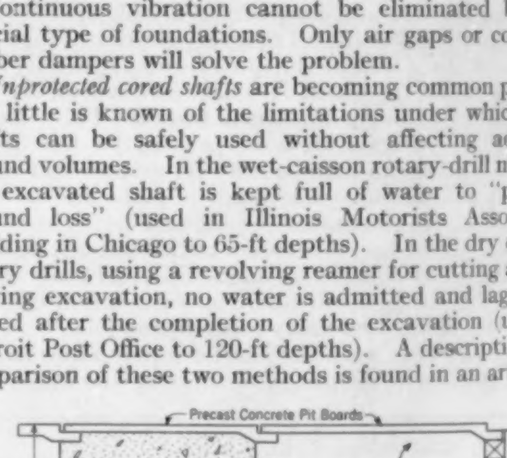


FIG. 2. PRE-CAST CONCRETE SHEETING

Construction Methods, November 1932, page 14. Similar coring in clays is often made for cast-in-place piles.

Pressure of water on caissons is definite and there is no disagreement on the value to be used. The pressure of mud and other materials below the stream bed level is not an agreed value. There are still some designers who

do not admit that such materials can produce pressures greater than the hydrostatic water pressure, or that full hydrostatic pressure plus soil pressure will act in submerged soils, and that the percentage of voids do not control the value of the hydrostatic pressure.

Construction methods for caissons, as well as construction equipment for shield-driven tunnels, are dependent upon assumed values of the frictional resistance of the soils on the sides of the tubes. A study of this problem

UTILITY PIPES CLOSE TO SURFACE PRESENT BACKFILL PROBLEM
Thorough Consolidation of Soil Here Will Be Difficult Without Breaking Mains and Ducts

must also consider the effect of friction-reducing methods such as water jets and expulsion of slurry to lubricate the outside skin, and enlarged cutting edges. Some recorded data are available to use as a general guide. The caissons for the Whitestone Bridge indicated frictional resistances sufficient to hold weights of 370 to 670 lb (buoyancy deducted) per sq ft of submerged skin.

In the Outer Drive Viaduct work in Chicago, steel shell caissons were sunk in sand by jetting only; the sand changed to free-flowing and came up along the outside of the shells (*Engineering News-Record*, January 28, 1932). However, in sinking caissons for the Carquinez Bridge in California, friction-reducing jets placed on the outside face were not of much use; the interior jets did aid in sinking through river silt, sand, volcanic ash, and clay.

A test of the frictional resistance of a 36-in. round concrete caisson in Chicago clay, to a depth of 65 ft, was re-

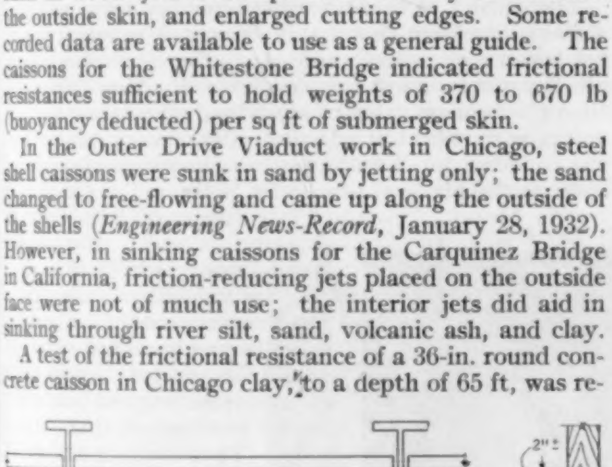
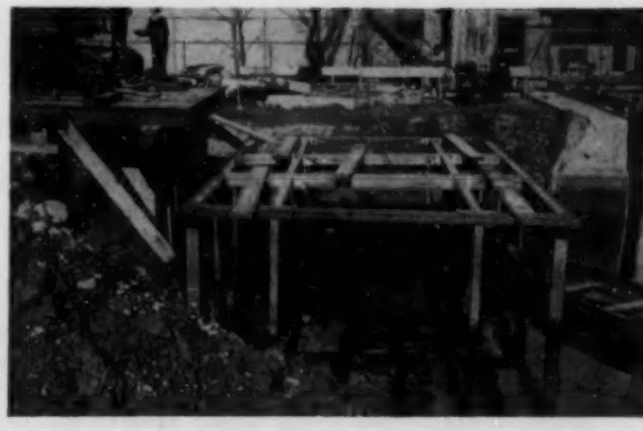


FIG. 3. HORIZONTAL WOOD SHEETING

ported by A. J. Hammond to be 800 lb per sq ft of caisson surface (CIVIL ENGINEERING, June 1931, page 868.)

The amount of water to be expected from well points, whether for water supply, water removal, or jetting of piles, is usually based on the manufacturer's standards.



THIS STEEL DRIVING FRAME FOR SHEET PILING WAS PREFABRICATED BEFORE BEING SET IN DREDGED AREA
Bottom Horizontal Bracing Beams, Similar to Top Ones, Are Just Below Surface of Water

Lack of proper study before installing well points is forgotten when they do not perform to expected values and the entire idea of well points is discarded as useless. As developed by Schutze in "Grundwasserabsenkung" (1924) based on the study of flow of water through sand by Poiseuille and by Darcy, the theory of well points can be applied to certain conditions. Extrapolation of these theories to clays, silts, gravel, and so forth, leads to disappointing results, in spite of manufacturer's recommendations.

Resistance to overturning of unbraced sheetpiling, or the depth of embedment for sheetpiling to withstand certain pressures, is an important problem. A similar item is the necessary depth of embedment for poles exposed to lateral pressures or pulls. Some data are available in the article by D. P. Krynine and R. W. Abbett (CIVIL ENGINEERING, May 1933, page 263). The methods developed by H. Blum in 1931 for determining bending moment on sheetpiling (found in translation in the Carnegie Handbook) is based on the assumption that the lateral resistance of the earth is twice the value given by the Coulomb theory for "passive pressure." It is slightly more economical than the method found in older editions of the Carnegie handbook, "Steel Sheet Piling."

A more accurate and more economical design can be obtained by the use of the other formulas also found in the later Carnegie handbooks, based on the work of H. Krey, *Erddruck, Erwiderstand und Tragfähigkeit des Baugrundes* (1926), which takes into account the vertical component of the pressures. The resulting design requires about 10 per cent less sheetpiling than from the Blum method, yet designs so made have proved safe.

The writer believes that the solution based on the most rational assumptions is that of M. A. Drucker (CIVIL ENGINEERING, December 1934, page 622, also May 1935, page 311, and September 1935, page 589). These articles cover the subject of sheetpiling, as well as poles and anchor piles.

Braced sheeting in excavations is partly covered in the preceding section. The additional question, where vertical sheeting is used, is the distribution of the total load on the sheeting to the various tiers of bracing. A great deal of variation exists in the several recent publications on this subject. Yet it can safely be stated that there have been no conclusive tests to disprove the basic earth-pressure theories. Proper account should be taken of the resistance developed by the embedment. The rest of the load can be distributed in any number of ways between the bracing frames as long as the calculated mo-

TWO-INCH PLANK FRAME, AT TOP ONLY, STABILIZES FOOTING PIT

ments do not show an excessive stress in the sheeting, the bracing frames are strong enough to take the reactions, and the frames are tight against the sheeting.

A rigid solution can be obtained by some such method as L. E. Grinter's "Determining Influence Lines by Balancing Angle Changes" (*Engineering News-Record*, October 6, 1938). But the accuracy of the solution can never exceed the degree of accuracy in the computed pressures. Also, actual conditions are affected by the customary trade practice in placing and wedging bracing, the top frames being first installed. The usual feeling on the job is that if enough total bracing is provided, the loads will take care of themselves.

In a recently developed practice, vertical steel columns are driven into the ground along the lines of the purposed excavation, and as the material is removed, timber slats are placed between the beams from the top downward. The slats are designed as simple slabs to sustain the earth pressure at the various depths. The columns, known as "soldier beams," are designed as restrained-end beams (because of the embedment), supported also at the various bracing levels. In cut-and-cover subway construction work, the only bracing level is the street decking, except for unusual depths, and spacing of the soldier beams is between 5 and 10 ft, the greater spacing being used in shallow cuts only. The Drucker method, previously referred to, is especially applicable to the design of soldier beams. Details of this method of sheeting are shown in Fig. 3. The sloping edges of the planks are provided for economy in material and ease in turning the plank into position; they also permit easy packing of the open gaps to reduce infiltration of water and soil.

Resistance of piles to penetration (as distinguished from bearing value under static test loads) is a matter concerning which little is known. At present the choice of pile-driving equipment (weight of hammer and fall or type) is made with some reference to what did not work well in previous jobs where conditions were apparently similar. The great driving resistance encountered with H-column piles has resulted in several types of cored ground methods, in which the columns are either placed in full depth holes or only partly driven, and then imbedded in concrete filling. The resistance to driving steel shell piles in riprap-fill areas (encountered very often along waterfront street improvements in established communities) has caused the development of obstruction-removal methods and tools (such as spuds and chopping bits) and even the use of dynamite at the bottom of the partly driven pipe. Some attempt at a rational choice of pile-driving methods and equipment is described by R. V. Allin in *Resistance of Piles to Penetration* (E. and F. N. Spon, Ltd., London, 1938).

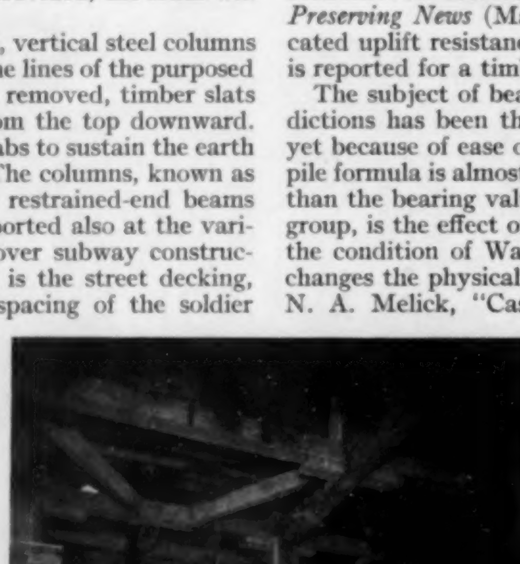
Proper planning of a pile-driving job is a great factor in reducing penetration difficulties. The necessity for preventing encirclement of areas in which piles are to be placed, is well known.

Resistance of piles to lateral forces is often desired, although recent tests seem to fill the gap in information. Besides the theoretical discussions already referred to, there are the articles by L. B. Feagin (TRANSACTIONS, Am. Soc. C.E., Vol. 102, 1937, page 236) and by H. A. Vierheller (*Engineering News-Record*, May 6, 1937, page 667).

Resistance of piles to uplift seems to have no relationship to expected or tested load-carrying capacity. In "Holding-Down Power of Concrete Piles," R. A. Allton and J. H. Blodgett (CIVIL ENGINEERING, February 1933, page 66) give values of from 511 to 722 lb per sq ft of imbedded pile surface—values quite in agreement with those used for caisson frictional resistance. Some tests on uplift resistance for creosoted timber piles are reported in *Wood Preserving News* (March 1940, page 28), where an indicated uplift resistance of 75 tons with a strain of 0.2 in. is reported for a timber pile 20 ft long.

The subject of bearing-value formulas, tests, and predictions has been thoroughly discussed in recent years, yet because of ease of application, the *Engineering News* pile formula is almost universally used. More important than the bearing value of an individual pile or even of a group, is the effect of adjacent piles on each other. For the condition of Washington silt, in which pile driving changes the physical properties of the soil, the paper by N. A. Melick, "Cast-in-Place Concrete Pile Work in Quaking Clay" (*Engineering News-Record*, May 23, 1939, page 823), is valuable; it also gives the measurements of the heaving effect from adjacent pile driving. In similar ground, cast-in-place concrete piles in cored holes show higher test values than driven piles. That the danger of cutoff at unknown depths by adjacent piles is not a theoretical objection was proved by excavating some piles cast in driven open-end pipe, where the pipe was removed as the concrete was poured. At least half the uncovered piles (in a fairly dense, wet clay) were found to be pushed out by side pressure by an amount greater than their diameter.

Many other problems besides those cited need further aid from soil mechanics studies. It is hoped that the examples discussed will awaken renewed interest in the development of much-needed solutions.



SUBWAY CUT IN EARTH HAS TYPICAL WALL SHEETING AND SUPPORTS
Extra Height and Width Provide Clearance for Shovel

Chicago Plant to Filter 320 Mgd

Substructure of South District Project Finished, and Completion of Entire Installation Expected in 1943

By Loran D. Gayton, M. Am. Soc. C.E.
Assistant City Engineer, Chicago, Ill.

Purification of water supply is a large half of the problem of protecting populations against the spread of water-borne disease. If sewage treatment works were more plentiful, purification would be less expensive and our rivers and beaches would be more usable. But until they become so, great projects, such as this one at Chicago for treating Lake Michigan water, will be vital to the existence of metropolitan communities. Mr. Gayton's article shows significantly how years of preparation and study are required to bring coordinated plans to the final stage of authorization and appropriation, and it gives an illuminating account of numerous construction and design features.

Filtration of the Chicago water supply has been discussed pro and con ever since Civil War days, when Ellis Chesbrough, then city engineer, had under consideration the matter of filtering the water supply through the natural sand on the lake shore. This scheme was never carried out; instead, a tunnel was driven out from the original Chicago Avenue pumping station under Lake Michigan, a distance of two miles, ending in the original Two-Mile Crib.

The opening of the main channel of the Sanitary District Drainage Canal in 1900, and the reversal of the flow of the Chicago River, diverted a great amount of Chicago sewage away from Lake Michigan and greatly improved the city's water supply. However, there was at the south end of Lake Michigan a rapidly developing industrial district that continued to dump its trade wastes into the Lake, and, in addition, the towns in northern Indiana used the lake as a point of disposal for their domestic sewage. Under certain conditions of wind and current, these trade wastes and sewage were carried into the areas surrounding the Chicago intake (Fig. 1). Conditions became so serious that in 1912 chlorination was adopted at the Four-Mile Crib, and by 1916 the city's water supply was being sterilized by chlorination at every one of the pumping stations.

Once more the matter of filtration was brought to the front by a somewhat localized typhoid outbreak on the South Side in 1923. In 1924, the writer, as engineer of water works design, made a study in connection with the proposal to filter the entire Chicago water supply, and in 1925 submitted recommendations bearing on the area of land required for the filtration plants and on the location of these plants in relation to certain changes in the shore line then being made by the Lincoln Park Board and the South Park Board.

The report went further and compared the cost of filters with that of deep-water cribs and tunnels. It was apparent that the crib-and-tunnel system could not give any guarantee of pure water at all times, for government engineers have found that wave action affected the bottom in 55 ft or more of water, and the effects of heavy rains and offshore winds were problematical. On the other hand, there seemed no doubt that filtration would give a satisfactory water supply, and there were many arguments in favor of placing the filtration plants adjacent to the tunnels at the shoreline. Only four large plants would be required. No money would be tied up in lands either for immediate use or for future extension. The cost of building such plants and operating them would be less than that of providing equal capacity in smaller units.

Experimental Plant Built

These findings were concurred in by John Ericson, then city engineer, and as a result we secured an appropriation for the construction of an experimental filtration plant, which was built and put in operation in 1928. Its purpose was of course to carry out various investigations in connection with the purification of the lake water in order to supply definite information upon which to base the economical design and operation of the large

Air View of Construction Stage in July 1940
Granulated Slag Fill Was Placed Behind Slag or Stone Dikes to Prevent Loss of Floating Material, and Was Covered with 4 Ft of Lake Sand

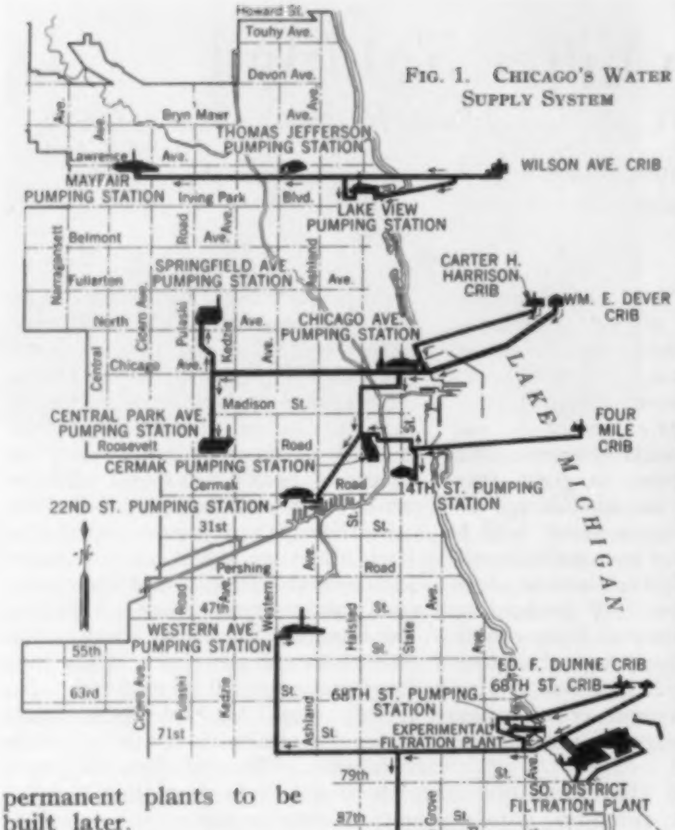


FIG. 1. CHICAGO'S WATER SUPPLY SYSTEM

permanent plants to be built later.

During the years from 1933 to 1936, the City presented five applications to the PWA for either a grant and loan, or a grant only, for the construction of the complete South District Filtration Project. Although these original requests were denied because the time required for the construction of the entire project was too great, a later application was approved, in August 1938, for a 45% grant in connection with part of the work—$12,035,000 worth. This amount of work was to be carried out within a period specified by the PWA. Since approving the original grant, the PWA has agreed to certain changes in the various items of work and has also granted an extension of construction time.

As the project now stands, the following units of work are included under the grant: the breakwater, the bulkhead or cofferdam, the park fill, the approach fill, the filtration-plant tunnels, the east substructure, the west substructure, the low-lift pumps and motors, certain cast-iron pipe and fittings, and certain sluice gates and valves, venturi tubes, and recorders. Under the agreement with the PWA existing in February, all the foregoing construction work had to be completed by March 1, 1941. After the termination of the grant period, the city is obligated to complete the rest of the project with its own funds provided no further PWA assistance is available. It is expected that the plant will be put in operation in 1943.

The plant (Fig. 2) will supply filtered water to three South Side pumping stations—the 68th Street, Roseland, and Western Avenue stations. The area served covers 115 sq miles, or 54% of the entire city. The present population in this area is 1,200,000, or 35% of the city's total. It is estimated that in 1950 the population will be approximately 1,300,000 and that in 1960 it will be about 1,400,000.

For the past four years, under a partially metered system, the average per capita consumption has been 250 gal per day. With 100% metering this should be reduced probably to below 200 gal. However, it should be kept in mind that the area under consideration has possibilities for great industrial expansion, and that industrial use may very possibly keep the consumption somewhat high.

At the usual rating of 2 gal per min per sq ft of sand area, this plant will have a capacity of 320 mgd, and it is being designed to handle a peak hour demand of 450 mgd. The time of mixing after addition of chemicals will be 58 min for a 280-mgd yearly average of water treated. This will give an average mixing time of 45 min for the maximum summer consumption of 300 mgd, and about 35 min for the peak hour demand of 450 mgd. For the yearly average of water treated, the settling time will be 4 hours, which will be reduced to $2^1/_2$ hours at the peak-hour rate.

Raw water from the Edward F. Dunne Crib passing through the filtration-plant intake tunnel enters an intake basin at the east end of the plant, several feet below lake level by gravity, and is screened before entering a suction well at the low-lift pump. Four 50-mgd and four 100-mgd direct-connected, electric-motor-driven, centrifugal pumps are provided to care for a peak load of 450 mgd. Various combinations of these pumps will care for fluctuating loads and provide spare units to guarantee uninterrupted operation. The flow from each pump is recorded by a venturi meter.

Each low-lift pump raises the raw water from lake level to an elevation 20 ft above, in a double-decked raw-water conduit. This double decking permits either or

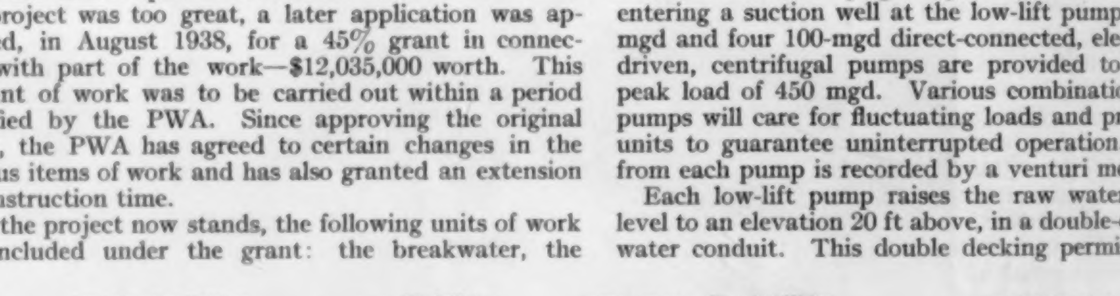


FIG. 2. TYPICAL CROSS SECTION OF SOUTH DISTRICT FILTRATION PLANT
Note Double Decking of Various Facilities

RUBBLE-MOUND BREAKWATER WAS FIRST UNIT COMPLETED

both levels to be used and allows cleaning of the conduit without interrupting plant operation.

From the raw water conduit, the water is metered to each of three mixing, coagulating, and settling basins, any one of which can be taken out of service for cleaning or repairs, as two will satisfy the maximum average daily requirements. The basins are 33 ft deep but have an intermediate settling floor at one-half this depth. Over the intermediate floors as well as over the bottom floors, sludge scrapers drag the sediment to one side of each basin, where cross collectors convey it to sumps, whence it is continuously removed.

This sludge runs by gravity to a sludge well and concentration tank, where the water is laundered off after concentration and returned to the raw-water intake, while the sludge itself is removed for further concentration and disposal. The treated water and its chemicals are thus reclaimed.

All filter wash water is returned by gravity to a sump from which it is pumped to the wash-water settling basins. There the sludge is settled out and the clear water is decanted over into the low-lift pump suction well. The sludge is added to that collected from the settling basin for further concentration and disposal.

Treated water then passes through sluice gates into a settled-water header in the filter building. Four settled-water laterals branch off from this header and, extending under the filter gallery floors, distribute their flow to four units of 20 filters each. Each unit discharges into a separate clear-water reservoir located below the filters. From this point the filtered water passes into a clear-water header discharging into the main clear-water reservoir, so arranged and divided by sluice gates that either half or all may be used. From the reservoir the filtered water passes through the outlet shaft to the underground tunnels which supply the pumping stations.

The chemical application and mixing basins are located above the meters, and each basin extends nearly the full width of the coagulating basin. Most of the chemicals will be added to the raw water in these basins and mechanically mixed there.

In addition to the rapid initial mixing, the water in each unit of the plant will flow through another chamber extending the height of both the meter and the chemical application basins. The depth of water in this chamber will be approximately 35 ft. To produce additional rapid mixing, the chamber will be provided with obstructions so placed as to produce approximately a uniform flow from top to bottom. Near the outlet end of this chamber will begin a dividing floor between the upper and lower coagulating basins. At this point an adjustable slot of uniform width extending from the bottom to the top of the chamber will be constructed for varying the area of the chamber exit to produce some definite loss of head. Such a loss of head, of from 1 to 2 in., should insure that equal amounts of water are added to the upper and lower coagulation basins.

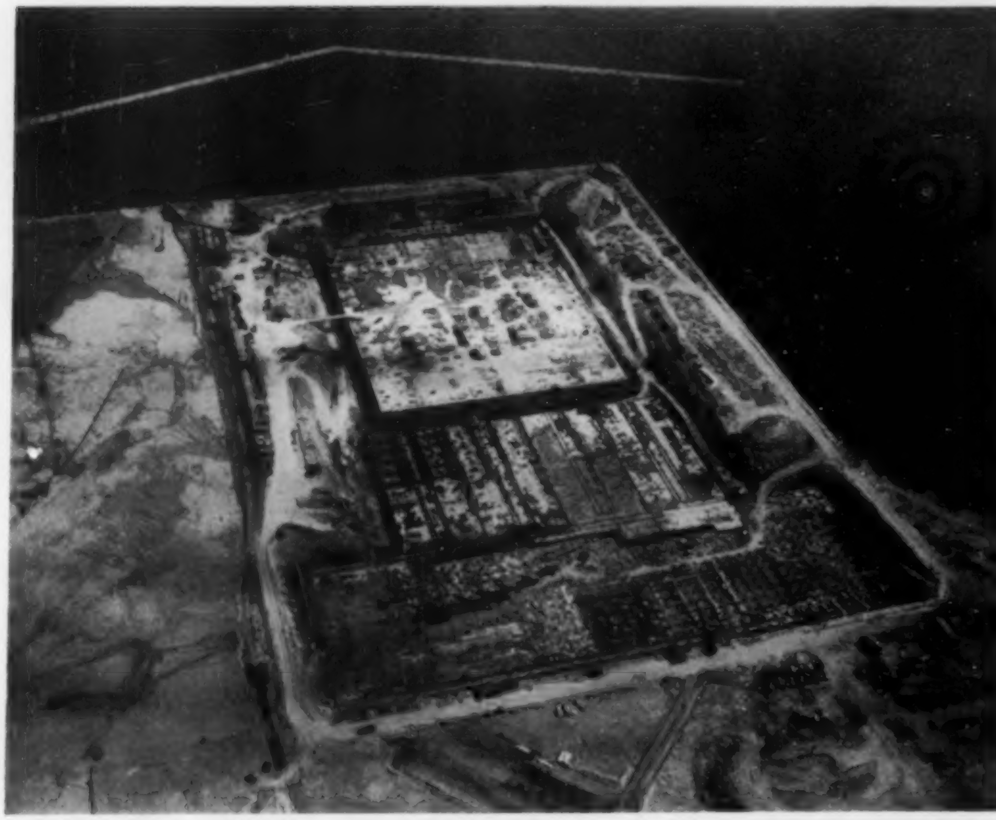
Coagulating basins will be equipped with mechanical agitators fastened to horizontal shafts. The passages are similar to those in the around-the-end type of coagulating basin. The water is agitated, but travels forward much more slowly than is usual in such basins. It will therefore be moving in the direction of the center line of the agitating device instead of across it, as is customary in the flocculator type of basin.

Baffle walls are spaced 20 ft on centers. There are six lines of agitators and the last passage acts more as a disturber for the settling basins than a part of the mixing basins. The water will flow through slots in the wall separating the coagulating basins from the settling basins. These slots will be provided near the bottom, near the center, and near the upper part of the wall. It is likely that the slots will remain partially closed during operation.

The settling basins are two-story structures with about 16 ft of water in each story. The water will pass from the coagulating basins through the settling basins, then under a curtain wall and up into a chamber where it may be recarbonated when lime is used in the treatment. From the settling basins it will pass through gates into a conduit that runs along the end of the basins and leads eventually to the filters. The water level in the settling basins will be slightly higher than that on the filters. About one-third of each settling basin is to be provided with continuous sediment-removing equipment.

Each filter unit will have a length of 54 ft, a width of 26 ft, and a surface area of 1,390 sq ft. The top of the wash-water troughs is to be set about 27 in. above the top of the sand, or at an elevation such that no part of the trough will touch the sand when the filter is in service. The wash-water gutter is to extend lengthwise of the filters, along one side wall. The top of the filter well is at El. +17.0. Bids on more than one type of filter bottom will be requested. The manifold is to be of concrete, is to extend along under the floor of the filter, and is tapered from the gallery end to the back of the filters.

The water contains microscopic organisms which tend to clog the filters unless they are removed before filtration. The experimental work has shown that the use of small quantities of lime aids in this removal. As for coagulation, any of the agents used for this purpose in water treatment is satisfactory for Lake Michigan water. Storage and feeding equipment will be provided for aluminum sulfate, ferrous sulfate, ferric sulfate, lime,



STATUS OF CONSTRUCTION IN SEPTEMBER 1940

sodium silicate, sulfuric acid, powdered activated carbon, ammonia or ammonium sulfate, and chlorine.

Since the foundation walls and piers of the substructure extend to bedrock, all earth within the plant limits was excavated to rock in order that the nature and condition of this rock could be accurately determined before construction began. The substructure is divided into two portions designated as the east and the west, and is entirely of reinforced concrete.

The east substructure is approximately 850 ft long by 480 ft wide and contains, in order from east to west: intake basin, screen chamber, low-lift pump room, raw-water header basin, chemical mixing basin, coagulating basins, and settling basins. In general, the coagulating and settling portions are divided into three similar basins, each double decked and separated from each other by galleries, which house the machinery for the flocculators and scrapers. The west substructure, approximately 700 ft long by 900 ft wide, will contain 80 filters grouped in units of 20, each filter having an area of approximately 1,390 sq ft. It will also contain the clear-water reservoir, with a capacity of approximately 50 million gal.

The galleries, which are designed as rigid-frame structures, and the retaining walls will be self-supporting and capable of resisting any external earth pressures or internal water pressures to which they may be subjected. The structure is also designed to resist any hydrostatic uplift that might occur when the basins are dewatered.

All design assumptions, unit stresses, and types of construction are in accordance with the provisions of the new Chicago Building Code where it applies. Because of the nature and purpose of the structure, special attention was given to the concrete plans and specifications as to watertightness, density, and surface finish. Approximately 0.45% of temperature or shrinkage steel is provided throughout the heavy gallery and retaining walls, which support heads of water varying up to 35 ft.

Because of the great length and width of the structure, a comprehensive system of expansion joints was developed. These are generally located about 160 ft center to center in both directions. Special care has been taken in all ways possible to prevent cracking in walls or slabs in the basins, or in galleries adjacent to the basins. Obviously, the reason for this is not only to prevent leakage from the basins but also to prevent infiltration of ground water or other sources of contamination. The prevention of cracking in structures of this nature is also particularly essential to safeguard the reinforcement against corrosion and the concrete against general deterioration.

All basins are anchored to bedrock. Flat-slab construction with "tied" columns is used wherever possible, as this type of design was found to be the most economical. Panels are generally 20 ft square.

Four superstructures will house the offices, laboratories, chemical and mechanical equipment, and supplies necessary for the operation of the plant. They will be of steel skeleton construction with brick or stone walls and reinforced concrete floors. The roof construction will in general be pre-cast concrete tile. The Administration Building, at the west entrance to the plant, will house the general offices, main chemical laboratories, wash-water pump room, and boiler room. This building has two wings approximately 34 ft by 100 ft, two stories high. A spacious lobby will connect it to the filter building, the over-all dimensions of which are about 400 by 600 ft. The latter houses the 80 filter beds together with their operating galleries, which are in the "west substructure" previously described.

The chemical building will be located at the east end of the plant over the chemical mixing basin in the substructure. It will shelter all chemical feeding equipment and will provide storage space for approximately a 30-day supply of chemicals. It is served with a rail spur and a 40-ft concrete roadway for truck delivery. It will have an approximate length of 480 ft and an average width of 60 ft. Directly to the east will be the low-lift pumping station and screen house. This building includes the low-lift pumps, a boiler room, the electrical equipment, a machine shop, and a screen room for servicing the screens in the intake basins. It is approximately 90 ft wide by 500 ft long and fronts on Lake Michigan.

Hon. Edward J. Kelly is mayor of Chicago. Hon. Oscar E. Hewitt is commissioner of public works, and John P. Wilson is deputy commissioner. Prior to February 1, 1941, all the work described was carried out under the direction of the writer as city engineer.

Photo-Surveying Assists Archeologists

Uncovering Ancient Art Objects in a 600-Year-Old Cemetery at Cocle, Panama

By Robert Hall Merrill, M. Am. Soc. C.E.

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SINCE 1930, when Mr. Merrill accompanied the expedition of Tulane University to Uxmal, Yucatan, and brought back detailed plans for reproducing a replica of "The Nunnery" at the Chicago World's Fair, locally known as "The Maya Temple," he has made similar field measurements for several archeological expeditions. The latest, here described, was the 1940 dig of the University of Pennsylvania Museum, which yielded a rare collection of pottery and gold art objects now on display at Philadelphia. Dr. J. Alden Mason was the anthropologist in charge. This article has been prepared from an address by Mr. Merrill before a meeting of the Michigan Section of the Society.

IN a monumental memoir on Sitio Conte, Dr. S. K. Lothrop has minutely described the results of the first three seasons of field excavation in Panama by the Peabody Museum of Harvard University; and he assisted our 1940 party from Pennsylvania University in resuming the dig where he had discontinued it seven years before. The site is in the province of Cocle, Republic of Panama, about a hundred miles west (on the North American side) of the Canal Zone and on the Pacific side of the Isthmus.

As the area is inundated during the rainy season, excavation work is limited to the three months of the dry season. During this period we were able to thoroughly search a section 50 by 30 ft to a depth of 14 ft (the depth to ground water). Within these limits—immediately adjacent to the richest finds of 1933—there were some two dozen graves, the chronological sequence of which was one of the main problems because some of the most recent burials were also the deepest.

In a single chieftain's burial place were found as many as 22 skeletons—war captives, slaves, and wives—besides food in pottery vessels (usually broken or ceremonially "killed" to release the spirit), clothing, and ornaments. The perishable parts had long since rotted away, although even textile fabrics were in places unmistakably preserved in the silt-clay backfill by casts faithfully showing the weaving patterns. Spanish chroniclers of the 1520's witnessed and described burial rites for native chieftans that closely accord with the findings of modern excavations in the vicinity.

It may be of interest to recount how this site became known to archeologists. On the delta flood plain some five miles off the paved Pan-American Highway and northeast of the nearest village, Nata, some years ago the Rio Grande de Cocle eroded a new channel and in the concave bank exposed shining breastplates of beaten gold, perfectly preserved and of exquisite design. The treasure was seen by a native canoeist who secretly returned and removed it. He sold the plates to jewelers in Panama City, and when the value exceeded several thousand dollars, the land owner brought suit for his 50 per cent of the bullion value allotted him by law. The ensuing publicity brought this particular site to the attention of the Peabody Museum. Half a dozen other ancient village sites in the immediate vicinity were known. One reported by Verrill showed an elaborate building plan, a rough counterpart of which Lothrop describes in his published Sitio Conte memoir.

With daily temperatures in the trench often exceeding 120 degrees, any expedients were welcomed to expedite the field work, the speed of which normally depends upon excavation that must be done with meticulous care. But even after a layer has been completely exposed, much work must be done before the objects can be removed. The specialist in anatomy records a detailed description of the bone remains; the pottery expert numbers for identification each group of sherds; and the archeologist records the several art objects with a view to reconstructing the original burial ceremonial.

To a draftsman is generally allotted the task of sketching to scale all the objects uncovered. Ten years ago when the writer was in central Europe with the American School of Prehistoric Research, working on the excavation of ninth century graves, he observed that the progress of the work was held up while the draftsman made, recorded, and later plotted to scale, triangulation measurements to two reference points (corners of coffins which often were indefinite because of decay) and measured depths (with reference to the coffin lid, for instance, instead of to some truly horizontal datum plane). We proposed to acceler-

Sun Shades and Watering Pot Become Scientific Necessities
Trench Temperatures of Around 120° Required the Former to Protect the Excavators, and the Frequent Application of the Latter Was Needed to Keep the Clay Silt in a Workable Condition

WHERE DRAFTING MAY BE PREFERRED TO PHOTOGRAPHY
Unbroken Pots are Easily Located by the Customary Method of Sketching, Using Two Tape Measurements from Two Fixed Reference Stakes. Although This Requires Replotting Later to Scale

ate this work and secure equal accuracy by substituting sketching directly to scale on section paper, the square cross-rulings corresponding precisely to accurate rectangular coordinates laid out on the ground at 2-m intervals. Within each 2-m square a sketching frame was used, having each edge decimally subdivided so that each small square of the interior network was 10 cm on a side.

ADVANTAGES OF PHOTOGRAPHIC METHOD OF LOCATING EXCAVATED OBJECTS

To supplement similar field sketches at Cocle, the writer advocated photographing vertically downward from a sufficient height on a 16-ft ladder to cover in the foreground a unit network 3 ft by 3 ft, subdivided into tenths of feet. These rectangular coordinates, accurately placed in plan, were also at some even unit elevation. With only slight parallactic distortion, such a photo shows every detail accurately to scale in plan, and for completion needs only the addition of accurate elevations, which may be put directly on the print without confusion if written in red. Identification numbers for each group of pot sherds were marked in black on the photo, and when these sherds were finally removed from the excavation in a paper bag, the corresponding number was marked in black on each bag.

If still greater precision is desired, for instance the exact location of a necklace, a smaller network with centimeter mesh may be substituted. As soon as one layer has been removed, the next lower layer is uncovered and photographed. When contiguous photographs have thus been taken covering all the squares in each layer, cross-sections along any vertical plane desired can be plotted to accurate scale from the complete data available on the series of plan maps. Thus it is possible to work out the relationship of any particular burial to all the others, and to the original ground surface.

Where literally hundreds of elevations from a single set-up are involved, the customary process of recording minus sights, subtracting them from the instrument height, and rewriting the computed elevations, may all be shortened by using an inverted self-computing rod with large movable digits, and sliding footpiece, which is clamped to read actual elevations directly. This permits the recording of every desired elevation directly on the enlargement print or sketch, immediately as the levels are read.

For extensive excavations of considerable importance, the added care of orienting coordinates to true north is justified. If a transit is not available this can easily be done with an opera glass, two plumb lines, a lantern, and a tape. The old reliable Polaris at elongation will do if accurate time is unknown; but portable radios nowadays give accurate time, and a star at any hour angle gives a fairly good azimuth.

By choosing the origin of the plan coordinates well to the south and east of any probable extension of the excavation, these two direction names are at once eliminated. Then, since latitude here is north and our local longitude is reckoned to the west, any even coordinate is completely described, for example, by 143 N and 89 W. The "N" and "W" are permanently marked on the measuring grid, and $1^1/_2$ by $2^1/_2$-in. white tiles bearing black numerals are placed to read right side up when looking forward on the respective coordinate lines, each number on the proper line just outside the unit square grid. The customary north point is then superfluous; one label of northing and one of westing graphically locates every small square in the grid network; and these very readable coordinate numbers also serve to identify the negative. In Panama the use of tile (instead of cardboard numbers) for this purpose is particularly advantageous, first because of prevailing high winds, and second because of the continuous sprinkling with watering pots that is required to keep the ground workable.

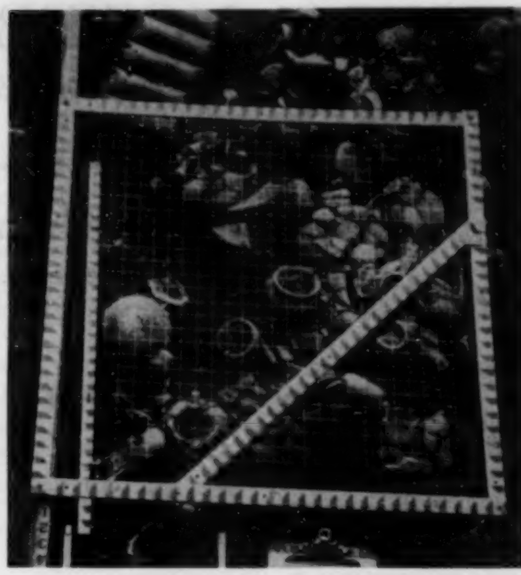
Where art objects are few and far between, it is quicker to sketch than to photograph, but even for this the grid is a great help. To facilitate sketching on decimally squared paper, where each fifth subdivision is distinctively marked, we use colored string at the even foot and 0.5 ft intervals in stringing up the grid.

At Cocle our makeshift ladder for photographing from above was a crude affair, made up with two 16-ft poles cut with forked tops. Its setting up required three men and it had to be roped to form a stable tripod. A modern tripod orchard ladder is available in the United States

WHERE SKETCHING WOULD GREATLY DELAY THE WORK
These Pots Were Ceremonially Broken, and Skeletal Remains (Upper Center) Are Imperfectly Preserved, but the Camera Quickly Records Every Smallest Detail

up to 16-ft lengths, and this can easily be handled by one man. Adjustable legs also are available if wanted. Only the top step assembly with special king-pin casting is necessary; then the long pieces may be added at camp if difficult to transport.

Two grid unit photographs may be made from a single ladder setting, first to the left, then to the right of ladder center; focusing on the ground glass at both extremes is easy. Thus the 900 small squares in the 3-ft unit are recorded first on one side of the carefully placed 12-ft stick, then on the other side. And this is repeated four times along the length of the stick. Thus from a single stick setting, 7,200 (8 × 900) small unit squares are recorded with uniform accuracy on the eight photographs. This multiple use of one stick setting justifies particular care in the initial coordinate work.



A Close-Up of the Square Frame in Place Over a Group of Sherds

The Yardsticks of the Frame Have Been Repainted in Tenths of Feet. Feet Are Strung in Red and Half Feet in Green to Match the Five Rulings to the Inch on the Drawing Paper

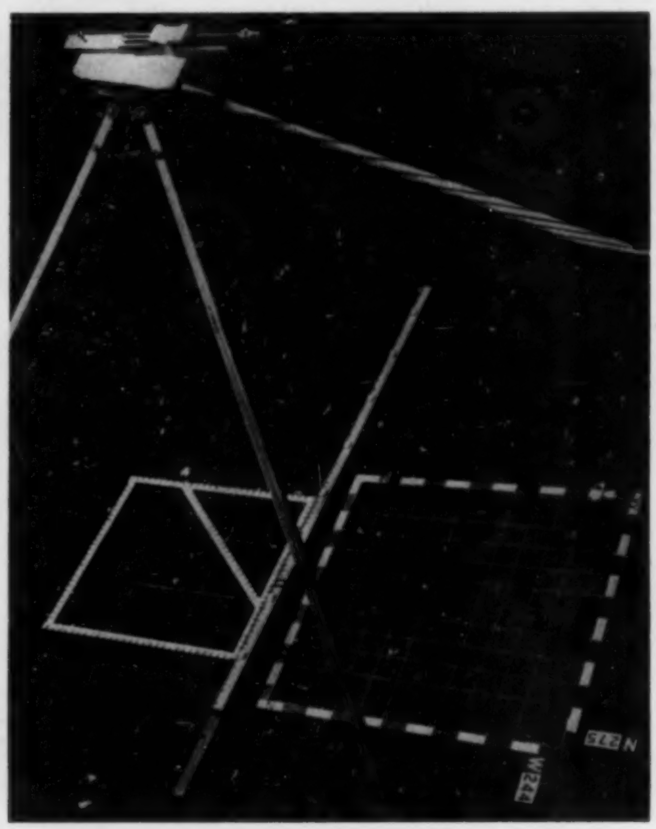
A sketching scale of one-sixth natural size was used at Cocle, and the camera took $2^1/_4$ by $3^1/_4$-in. cut film. To make the photographs match the field sketches then required simply a threefold enlargement. Separate prints could be devoted if necessary to skeletal material, to gold objects, or to pottery or other material. Duplicate exposures were taken of each square, the first one with the grid in place and the second without it to reveal details without obstruction.

Lacking a dark room at Cocle, we had to wait a week for the return of prints from Panama City, and incidentally ran the risk of losing individual pictures. When we went to Uxmal we avoided this difficulty by taking along a professional photographer. The results proved that the tropical obstacles to film development could be overcome, and we were able to make sure we had good progress pictures before we advanced from one operation to the next.

Negatives exposed at the close of a day's work could be developed at night, so that an enlarged print would be ready the next morning to have recorded on it identification numbers and elevations (in red) as soon as they were determined in the field. This procedure not only saves hours of scale sketching, but yields superior results in less time and with no delay to excavation progress if carefully planned. The exacting requirements of archeological research were quite adequately met by the method described.

Our Makeshift Ladder in Place for Photographing

Even with Such Crude Equipment Much Time Was Saved by Photographing This Broken Pottery Through the Coordinate Grid



A Modern Tripod Ladder Like This Would Have Saved Us Trouble at Cocle

Inverted Self-Computing Level Rod Has Movable Foot Numbers and Sliding Lower Section

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Safe Sight Distances for Highways

By Cleveland B. Coe, Assoc. M. Am. Soc. C.E.

Associate Highway Engineer, Tennessee Valley Authority, Chattanooga, Tenn.

It is almost an "old saw" that improvements in the structural features of highways and in the mechanical details of vehicles have increased vehicle speeds, and in turn raised highway standards. Much design effort is being applied to keep new highway construction abreast of the times and to eliminate danger spots in highways of the older types.

Many four-lane roads are being constructed, but for a long time to come roads of two lanes will continue to be built, and such roads will probably always constitute a large percentage of all highways. Passing on a two-lane road requires the use of a lane that may at any time be occupied by opposing traffic. This means, among other things, that there must be a clear sight for a certain distance ahead, and this distance depends upon the time a vehicle needs to swing out into the other lane, pass the obstructing vehicle, and swing back again. This distance is named the "passing minimum sight distance" by R. E. Toms of the Public Roads Administration (*Engineering News-Record*, January 13, 1938, page 75). He recommends that such a distance be provided at intervals of not more than two miles.

The ability to turn out of a lane is limited by the resistance to skidding. Joseph Barnett, M. Am. Soc. C.E., of the Public Roads Administration (*Transition Curves for Highways*, Government Printing Office), gives the following formulas for the minimum radius of curvature:

$$R = 0.418\ V^2 \text{ (0 to 60 miles per hr)} \qquad (1)$$

$$R = 0.478\ V^2 \text{ (70 miles per hr up)} \qquad (2)$$

where R is the desired radius as shown in Fig. 1, and V the car velocity in miles per hour. The minimum dis-

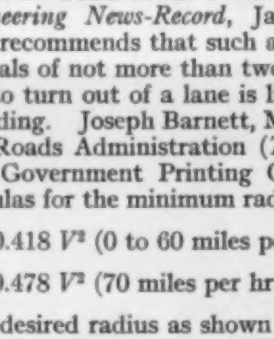


Fig. 1. Turnout Distance

tance in which a car can pass from one lane into another is

$$d = \sqrt{40R - 100} \qquad (3)$$

The lateral distance between axes of travel is assumed to be 10 ft. Note that the velocity of the obstructing car does not affect this distance—the resistance to skidding is the controlling factor.

Then, if the car must turn into the other lane, pass the obstructing car, and turn back in time to avoid an on-

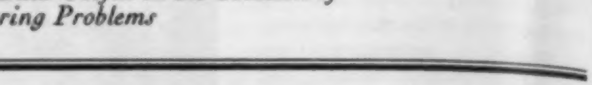


Fig. 2. Passing Minimum Sight Distance

coming car traveling at the same speed, the passing minimum sight distance (Fig. 2) will be

$$P_m = 2\left(2d + 32 + \frac{16\ V_2}{V_1 - V_2}\right) \qquad (4)$$

in which d is as given in Eq. 3; the length of cars is assumed to be 16 ft; V_1 is the assumed velocity of the passing car and of the approaching car in miles per hour, and is the allowable design speed of the highway; and V_2 is the velocity of obstruction in miles per hour. The

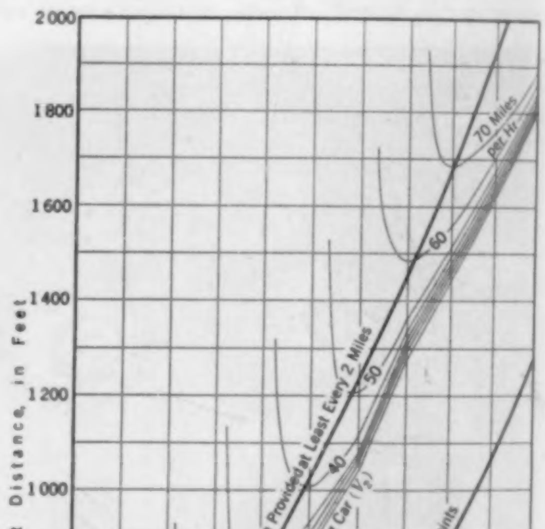


Fig. 3. Relation of Sight Distance to Velocities

distance indicated by Eq. 4 is given in Fig. 3. The family of curves shows the effect of different velocities of the obstruction. For design, the heavy line connecting the minimum points is used. This distance should be provided at least every two miles.

Recommendations of the American Association of State Highway Officials ("A Policy for Sight Distance for Highways," American Association of State Highway Officials, 1940) are much higher and depend entirely on an assumed difference of 10 miles per hr between V_1 and V_2. For comparison, they are presented here, as follows: For 40 miles per hr, 1,100 ft; for 50 miles per hr, 1,600; for 60 miles per hr, 2,300; for 70 miles per hr, 3,200.

For safety from non-moving obstructions, a clear sight distance equal to a safe stopping distance must be maintained at all points on the road. This has been made the object of many tests, which have given widely divergent results owing to the difference in physical characteristics of cars, tires, and surfaces. Mr. Toms states that a desirable relation is

$$D = 10\,V \quad \ldots\ldots\ldots\ldots (5)$$

The State of Massachusetts requires the ability to stop within a distance of

$$D = \frac{V^2}{10} \quad \ldots\ldots\ldots\ldots (6)$$

C. D. Vail, M. Am. Soc. C.E., State Highway Engineer of Colorado, states (CIVIL ENGINEERING, September 1940, page 568) that Western states use

$$D = 4.4\,V + \frac{V^2}{12} \quad \ldots\ldots\ldots\ldots (7)$$

an equation that takes reaction time into account. The curve resulting from this formula is shown in Fig. 3, as the lower heavy line. It is interesting that a cardboard "slide rule" issued by a tire manufacturer, giving stopping distances at various speeds on different surfaces, gives results for wet smooth brick and standard anti-skid treads almost exactly equal to those found from Eq. 6, whereas Eq. 5 gives results much higher than their worst condition, that of wet slush on concrete.

In applying the sight distances taken from these curves, most highway organizations use charts or formulas based on a $4^1/_2$-ft height of eye above the pavement.

Reinforced Concrete Columns Subjected to Bending About Both Principal Axes

By G. E. TROXELL, M. AM. SOC. C.E.

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MOST texts on reinforced concrete consider only the simpler types of eccentrically loaded columns. No text is known to consider the case of a rectangular or square column having bars along all four faces subject to axial loading and to bending about both principal axes, even though this case frequently arises in the design of reinforced concrete structures.

To determine the maximum stress on sections all parts of which are capable of carrying both tensile and compressive stresses, or on sections subjected only to compressive stresses over the entire area, the equation $S = \frac{P}{A} \pm \frac{M_1C_1}{I_1} \pm \frac{M_2C_2}{I_2}$ is commonly used. A somewhat similar relationship may be used for non-homogeneous sections of concrete and steel irrespective of the magnitude of the bending moments, even though the concrete is not capable of carrying tensile stresses. Suitable diagrams[1,2,3] have been prepared to assist in the determination of stresses in non-homogeneous rectangular sections having steel reinforcement along two opposite faces only, and subjected to axial stress and bending about one principal axis. It becomes a simple matter to extend their use to the more complex cases.

For rectangular columns carrying bending moments about both axes, the procedure is as follows: (1) Determine the maximum compressive stress in the concrete and the tensile stress in the steel caused by a part of the axial load and the bending moment about one axis. (2) Determine corresponding stresses due to the remainder of the axial load and the bending moment about the second axis. (3) Add the partial stresses from Steps 1 and 2 to obtain the total compressive and tensile stresses. The division of the axial load between Steps 1 and 2 has no effect upon the final results, at least so long as the same general variation of stress exists for the two axes, that is, as long as compression only occurs for both axes, or both tension and compression occur for both axes.

For columns having three or more steel bars along all four faces, the bars being symmetrical about each axis, it is sufficiently accurate to determine the maximum compressive stress in the concrete by computing the

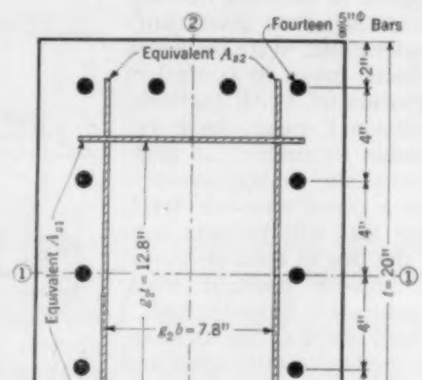

FIG. 1. ARRANGEMENT OF ROUND-BAR REINFORCEMENT IN CONCRETE COLUMN

equivalent position of the bars when at that uniform distance from the central axis of the section which makes the hypothetical I_s for the equivalent position of the

bars equal to the actual I_s, and then proceed as though all bars were located at this distance from the axis. For the maximum tensile stresses in the steel bars, the actual location of the bars farthest from the axes must be used. This approximate procedure for handling bars at various distances from the center of the section checks the precise method[4] within about 5% and saves much unnecessary work.

Although minor approximations are introduced in the type of analysis outlined here, a more accurate analysis cannot be justified. The effects of creep and shrinkage alone may cause the total deformations for axial loads to be as much as three times the initial elastic deformation. Furthermore, there are usually many unknown factors and empirical assumptions involved in the determination of the loads and their distribution. Upon consideration of these uncertainties in the theory and the data used in the analysis, the designer will agree that he should not attempt calculations of a higher degree of accuracy.

The application of the procedure described may be best shown by the solution of a practical problem, using the general method of analysis given in the Reinforced Concrete Design Handbook.[1] Consider a 13 by 20-in. concrete column reinforced with $14\,^5/_8$-in. round bars arranged as shown in Fig. 1. Take $n = 10$, axial load $N = 40$ kips, bending moment M_1 about Axis 1 = 200,000 in.-lb, and bending moment M_2 about Axis 2 = 100,000 in.-lb. Then $A_s = 4.3$ sq in., $p = 0.0165$, and $np = 0.165$. From the equivalent location of the steel on each side of each axis, g_1t for Axis 1 = 12.8 in. ($g_1 = 0.64$), while g_2b for Axis 2 = 7.8 in. ($g_2 = 0.60$). Let one-half of the axial load be considered to act with each bending moment. Then $N_1 = N_2 = 20$ kips. By use of Diagram 30 in the Handbook, the values in Table I are obtained. Thus, the maximum compressive stress in the concrete is 580 lb per sq in., and the maximum tensile stress in the steel is 4,100 lb per sq in. In computing the stress in the steel, note that $g_1 = 0.80$, while $g_2 = 0.69$.

TABLE I. STRESSES IN CONCRETE AND STEEL

Axis	N	e'	e'/t	g	k	Q	f_c	f_s
1	20	10	0.50	0.64	0.48	4.3	330	2,900
2	20	5	0.38	0.60	0.57	3.3	250	1,200
1 + 2	40						580	4,100

For square sections having the same reinforcement on all four sides, or having a round core, it is convenient to add M_1 and M_2 and consider their sum to act about one axis. For round columns, the resultant moment $M = \sqrt{M_1^2 + M_2^2}$ should be used.

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4 Dunham, Clarence W., *Theory and Practice of Reinforced Concrete*, McGraw-Hill Book Company, New York, N.Y., 1939, page 179.

Time Required to Saturate an Earth Dam

By K. P. KARPOFF

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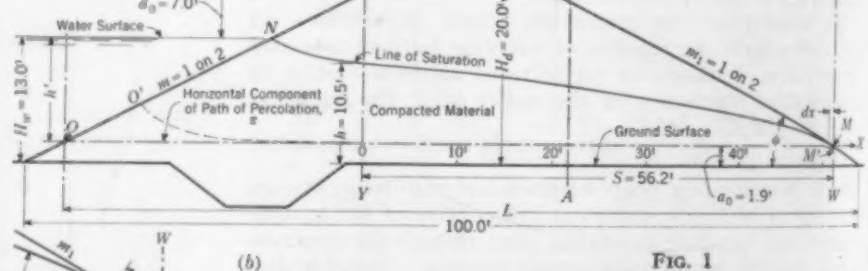
In the design of earth dams the time required to saturate the embankment is too often given only slight consideration. With increased attention being given to control of the construction of earth embankments, additional means have become available to enable the engineer to check the design assumptions. For a given reservoir level, the seepage loss will become constant and the line of saturation will reach its highest position when complete saturation has occurred.

Since a field check of the ultimate position of the line of saturation and the seepage loss can be made only after complete saturation has taken place, a knowledge of the time required to saturate the embankment is desirable. The theoretical time of saturation can be checked in the field by recording the time required for saturation to advance to successive hydrostatic indicators installed in a cross section of the embankment.

From Pavlovsky's theory (translation by Andreas Luksch and W. F. Bingham, in "Technical Memorandum No. 383," U.S. Bureau of Reclamation) the writer has developed a formula for the theoretical time of saturation in homogeneous earth dams. The successful application of such a formula is dependent upon the extent to which a rigid control of the embankment construction has made possible an accurate knowledge of densities, percentage of voids, percentage of moisture, and percolation rates.



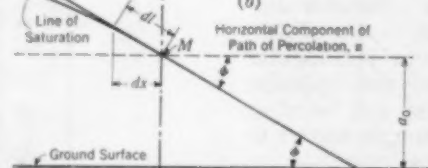


FIG. 1

A brief summary of the theory of the flow of water through an earth embankment may aid in understanding the principles on which the proposed formula is based. Pavlovsky considered only an embankment with an impervious foundation. However, the theory is approximately applicable to dams on pervious foundations. In the latter case the percolating water will appear in the foundation as well as in the fill itself. The rate of percolation and the volume of flow through the compacted fill will differ from the rate and volume through the foundations largely because of the differences in densities and voids. A dam designed for an impervious base, but to be constructed on a porous one, will have a line of saturation lower than assumed. This will add stability and

safety to the embankment section or will permit economic modifications in the design.

The derivation of the general formula for the line of saturation in a homogeneous earth dam can be simplified by considering a section of an earth fill of unit thickness, as shown in Fig. 1(*a*). As in the "central part" of the profile of the dam, the percolation is not uniform in the horizontal underlying layers. For clearness consider the differential equation. At any section *A-A*, the velocity of percolating water in Dupuit's formula, as used by Pavlovsky, is

$$v = -k\frac{dy}{dx} \quad \text{.................}(1)$$

where k is the velocity of water through a unit area of soil in unit time under unit potential gradient (coefficient of permeability). Substituting Eq. 1 in the formula for unit discharge yields

$$q = vy = -ky\frac{dy}{dx} \quad \text{.............}(2)$$

and by integration

$$\frac{qx}{k} = -\frac{1}{2}y^2 + c \quad \text{............}(3)$$

At section *Y-Y* (Fig. 1) $x = 0$, and $y = h$. When these values are substituted in Eq. 3, $c = \frac{1}{2}h^2$. The general formula of the line of saturation is then

$$y^2 = h^2 - \frac{2qx}{k} \quad \text{..............}(4)$$

At section *W-W* the line of saturation is tangential to the downstream slope at point *M*.

To derive the time of saturation for an embankment, consider only that part of the unit section which is under the line of saturation and between the upstream slope *O-N* and section *W-W*. The small wedge between section *W-W* and the downstream toe is neglected because (1) in a properly designed embankment, this section is usually quite small, with a_0 being between 1 and 3 ft for dams under 30 ft in height; (2) the saturation of this section is accelerated by the water flowing down the slope from point *M;* and (3) in larger dams (over 30 ft in height) the wedge below section *W-W* is usually a part of the drainage system and is filled with rock and gravel as shown in Fig. 2.

As illustrated in Fig. 1 (*b*), let

- x = horizontal component of the path of percolation at the depth h' from the reservoir water surface
- l = distance measured along the path of percolation
- h' = loss of static head
- J = gradient = $\frac{h'}{x}$
- U = velocity of percolation water at point $M = kJ = k\frac{h'}{x}$
- k = coefficient of permeability obtained by laboratory percolation tests at construction densities
- $m:1$ = upstream slope
- $m_1:1$ = downstream slope
- ϕ = angle of downstream slope

With a known velocity U at point M, the time, dt, required for the water to travel an increment of distance along the line of saturation, just before it reaches the point M will be:

$$dt = \frac{dl}{U} \quad \text{.................}(5)$$

but, since at point M (see Fig. 1*b*) the downstream slope is tangential to the line of saturation, and since the variation in the angle ϕ is negligible, the relation between dl and dx is

$$dx = dl\cos\phi, \text{ or } dl = \frac{dx}{\cos\phi}$$

Substituting in Eq. 5 the values of U and dl, we obtain:

$$dt = \frac{dl}{U} = \frac{x\,dx}{kh'\cos\phi}$$

and integrating between the limits O and L (Fig. 1*a*), we have

$$t = \frac{L^2}{2kh'\cos\phi} \quad \text{...............}(6)$$

A path of percolation may be defined as any line along which the water travels through the embankment. At the beginning of the period of saturation the particles of water traveling along these lines have their maximum velocity, this being their initial velocity, and as the distance of travel from the upstream face increases, as from point O', the velocity of the saturating water decreases. The velocities of penetration decrease between the upstream face and the downstream face in proportion to the resistance in the path, and the resistance throughout the embankment is such that the final velocities at the point M are equal. This is true only during the period in which saturation occurs, and will not apply after saturation has been completed and seepage flow has begun.

For simplicity in computing the time of saturation, the horizontal line *O-M* has been used rather than the actual path *O'-M*, which is of somewhat shorter length. The slightly longer path is conservative in that the time indicated will be for a little longer period, which would insure that the line of saturation had reached its maximum elevation.

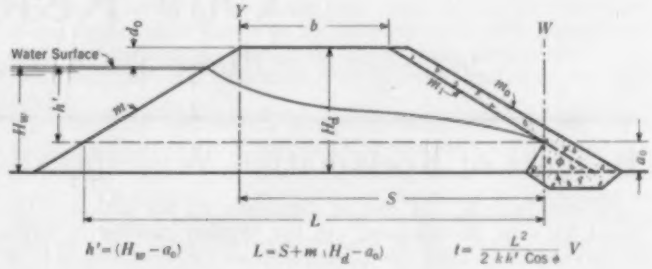


FIG. 2

Equation 6 is the formula for computing the time required to saturate the unit section of the dam, provided the material is in a surface-dry condition. With the present method of construction of earth dams, considerable water is applied during construction. At the end of construction a large portion of voids in the material will be filled with water, some of which will remain for a long period of time, probably until the reservoir is filled. In computing the time required to reach a state of saturation, this residual moisture must be taken into consideration. To do this, a correction factor V (see numerical example), may be introduced to represent the percentage of voids in the compacted material unfilled by water after the completion of the structure and at the time the reservoir is filled. Any diminution in the residual water will be affected by the character of the material, size of the embankment, and time elapsed between construction and filling of the reservoir.

The general formula for the time required to reach a state of saturation in a homogeneous embankment will now be

$$t = \frac{L^2}{2kh' \cos \phi} V \quad \text{.............. (7)}$$

Substituting values of L and h' from Fig. 1(b) we obtain the specific formula,

$$t = \frac{[S + (H_d - a_0)m]^2}{2k\ (H_w - a_0) \cos \phi} V \quad \text{.......... (8)}$$

Numerical Example. Consider the embankment shown in Fig. 1. The following values are known:

Total height (H_d) = 20.0 ft	Upstream slope = 2:1; m = 2.0
Freeboard (d_0) = 7.0 ft	Downstream slope = 2:1; m_1 = 2.0
Upstream head (H_w) = 13.0 ft	
Tailwater (h_0) = 0.0 ft	Angle of slope (ϕ) = 26° 34′
Width of top (b) = 20.0 ft	Cos ϕ = 0.895

From tests made during construction, these physical properties of the embankment materials were determined:

Percentage of water used in construction (by dry weight) = 9.7%
Dry density during construction (soil + rock) = 121.7 lb per cu ft
Consolidated dry density (soil + rock) = 128.1 lb per cu ft
Absolute dry density (soil + rock) = 159.3 lb per cu ft
Percolation rate, k = 3.37 ft per year (corrected for soil and rock)

To proceed with the problem, it is necessary to know a_0. This may be determined by the solution of the simultaneous equations:

$$\frac{q}{k} = \left(\frac{H_d - d_0 - h}{m}\right) \log_e \left(\frac{H_d}{H_d - h}\right)$$

$$\frac{q}{k} = \frac{h^2 - (a_0 + h_0)^2}{2s}$$

$$\frac{q}{k} = \frac{a_0}{m_1}\left[1 + \log_e \left(\frac{a_0 + h_0}{a_0}\right)\right]$$

$$s = b + m_1 [H_d - (a_0 + h_0)]$$

In this case the value of a_0 was computed to be 1.9 ft.

From the relations shown in Fig. 1(b) we can now solve for S.

$$S = b + (H_d - a_0)m_1 = 56.2 \text{ ft}$$

The correction factor, V, is determined by subtracting the percentage of water (by volume) remaining after construction from the total percentage of voids, as determined from the consolidated dry density and the absolute dry density.

$$\text{Total voids} = \frac{(159.3 - 128.1)}{159.3} = 19.6\%$$

$$\text{Water-filled voids} = \frac{121.7 \times 0.097}{62.4} = 18.9\%$$

$$\text{Unfilled voids} = V = 0.007$$

Substituting these values in Eq. 8 gives

$$t = \frac{[56.2 + (20.0 - 1.9)2.0]^2}{2 \times 3.37(13.0 - 1.9)\,0.895} \times 0.007 = 0.893 \text{ years}$$

or 10.7 months

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Benefits of Reclamation Widespread

TO THE EDITOR: In closing discussion on my article, "The Broad View of Reclamation," in the October number of CIVIL ENGINEERING, I should like to comment on the discussion of it by J. L. Campbell, M. Am. Soc. C.E., that appeared in the December issue.

I would be the last to deny that our reclamation program misses perfection, but it seems to me that a Californian should be among the first to see that irrigation improvements are absolutely vital—in this day and at this stage in the development of our country—to the welfare of the population of the Western states. It is well and good to blaze away with both barrels and with eyes closed at a target as big as a barn labeled "over-development of water supply," but if one does indulge in such reckless sport he should make sure that he does not kill most of the poultry and livestock in the barnyard. The Bureau of Reclamation is not responsible for the over-development of the underground water supplies in the San Joaquin Valley. It feels as strongly as does Mr. Campbell on the general subject of over-development of water supplies. The Bureau realizes, however, that the economy of California, and probably the welfare of even Mr. Campbell, depends upon the preservation of values in the Central Valley, which are threatened by exhaustion of underground supplies and which can be salvaged by the Central Valley Project.

Let those who cry out against reclamation as an aid to agriculture look about them and see for themselves that its greatest benefits accrue to urban populations, to state and federal governments, and to the people at large. Let them inveigh, instead, at a system of levying the charges for reclamation which, in most instances, saddles the costs on the farmer and the user of power, and lets the people of the cities off scotfree.

In his letter in the March issue John E. Field, M. Am. Soc. C.E., provides answers to some of the questions that have been raised in the discussion. I agree with Mr. Field that the abandonment of submarginal farms and reclamation are not in conflict. Rather the need for reclamation of good land is increased by forced abandonment of farms which have been exhausted through the mishandling of soil, because of aridity as in the Dust Bowl, and because poor lands were settled. In truth, the reclamation program is part and parcel of the larger program to readjust land uses.

JOHN C. PAGE, M. Am. Soc. C.E.
U.S. Commissioner of Reclamation
Washington, D.C.

Protecting Military Airports Against Bombing

TO THE EDITOR: The article by Mr. Hersum on "Protective Designs for Military Airports," in the December issue, offers interesting possibilities in design of shelters.

The data showing the enormous cost of bomb-proof protection might well have been given even more emphasis. According to Mr. Hersum's estimates, the cheapest kind of shelter envisaged would cost about $1,080,000 for the protection of 12 planes in the manner shown in Fig. 1, exclusive of "foundations, doors, runways, elevators, and equipment." Probably, if such an expensive bomb-proof roof were to be provided, several different floors could be built in order to multiply the capacity of the hangar without proportionate increase in cost.

As has been pointed out, the provision of heavy bomb-proof shelters for aircraft is a last resort, which costs more than the

plane it protects and is only to be used when less expensive means cannot be applied. As Mr. Hersum says, "An adequate warning system coordinated with protecting planes is the best defense." For continental air defense in war time, it is desirable that only pursuit and reconnaissance planes be kept regularly at points that may become subject to surprise attack. Bomb-proof shelter and anti-aircraft protection are so costly that the regular station of bomber commands, and the repair and training facilities for all types, should whenever possible be located either far in the interior or in other areas of such strategic importance that adequate defense by fighter planes will always be available.

For advance air bases, near frontiers or coast lines or in the theater of operations, full use should be made of dispersion, concealment, camouflage, and duplication of facilities. Protection by balloon barrage and anti-aircraft artillery, and use of cover against incendiary and other light bombs, will reduce the damage from sudden attacks by light bombers. Minimum command and service facilities at an advance base may be bomb-proofed even though the planes and runways are not. For reasons of cost, provision of heavy bomb-proof shelter for all elements should ordinarily be restricted to air bases of permanent strategic importance, located at points where the enemy can obtain local air superiority without warning and where adequate concealment and dispersion are impossible. If bomb-proof hangars must be provided, problems of space become as acute as they are aboard an aircraft carrier. In such cases there would be a great advantage in the use of planes of special type, with reduced wing spread or folding wing panels.

The decision as to type and degree of protection against bombing to be provided in an air base must be made separately for each case in full knowledge of all the engineering as well as military factors involved. Contributions such as Mr. Hersum's aid national defense by providing a sound professional background for a highly controversial subject.

William Whipple, Assoc. M. Am. Soc. C.E.
Fort Belvoir, Va. *Captain, Corps of Engineers, U.S. Army*

Error of Omission

Through an editorial oversight, appropriate recognition of the origin of Professor Wilson's paper on "Effects of Curvature in Supercritical Flow" was omitted from the February issue. The experiments upon which the paper was based were conducted at the University of Iowa under the immediate direction of Prof. E. W. Lane with the advice and assistance of Prof. Hunter Rouse. The entire study was part of a thesis submitted by Professor Wilson toward the fulfillment of the requirements for the degree of Doctor of Philosophy.—*Editor.*

Comparison of Runoff Records in India and America

To the Editor: In connection with analyses of runoff records that have appeared in Civil Engineering, it occurs to me that certain runoff data, available for India from my experience in irrigation and hydraulic research work, may be of interest to American readers.

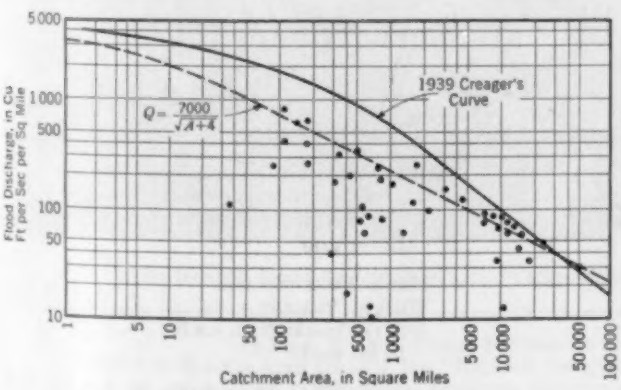


Fig. 1. Chart of Data Obtained in India

Points shown in the accompanying Fig. 1 represent data obtained in India, and may be compared with the curve of the writer's formula,

$$\text{Runoff} = \frac{7{,}000A}{\sqrt{A+4}}$$

applied to fan catchments in India. For further comparison the writer has shown, also, a curve for American data, given by William P. Creager in an article entitled "Possible and Probable Future Floods," in the November 1939 issue of Civil Engineering.

C. C. Inglis, M. Am. Soc. C.E.
Director, Central Irrigation and Hydrodynamic Research Station
Poona, India

Better Weather Observations at Less Cost

To the Editor: The President probably had no thought that he was changing the official climate a little at some points when, in reshuffling the government departments, he handed to the Department of Commerce the Weather Bureau (for about half a century in the Department of Agriculture) and Civil Aeronautics (an independent division). Amid the confusion that all such changes temporarily make, it is becoming apparent that too many weather observations have been taken under the "straining at a gnat and swallowing a camel" principle.

As the country has become increasingly air-minded the Weather Bureau has been giving more and more service to airports. In the past the service usually required the operation of a minor branch from a main downtown office; in the new set-up in most cities all weather work is being merged at the airport.

The outcome in the case of Rochester, N.Y., is probably fairly typical. Its airport and Old Federal Building (where the main office of the Weather Bureau was housed) are $4^1/_4$ miles apart. The old plane of observation was about 90 ft above the ground, and for 49 years observers carefully took their readings at this height. Nevertheless, those data were not truly representative of the atmosphere in which people were living and working, as they were modified by altitude, heat radiations from chimneys and roofs, and wind effects.

Fortunately the natural conditions inherently required for a modern airport—that is, an open and unobstructed field and surrounding territory—are almost ideal for observations of natural weather phenomena. Hence it is not surprising to learn that, in the duplicate observations made in recent years at Rochester's two stations, the airport observations showed considerable variation from those made at the Federal Building, with the greatest variations at extreme temperatures. The temperature differences average from 3 to 4 deg with extremes of as much as 10. The airport is the cooler in both winter and summer, and its winds, in both directional and intensity phases, are also noticeably different. So the net result of the President's merger then can only be that Rochester weather officially becomes cooler in and after November 1940, and an arithmetically flawless but in some ways inept 49-year climatological record must be abandoned and a new one slowly built up with the succeeding years.

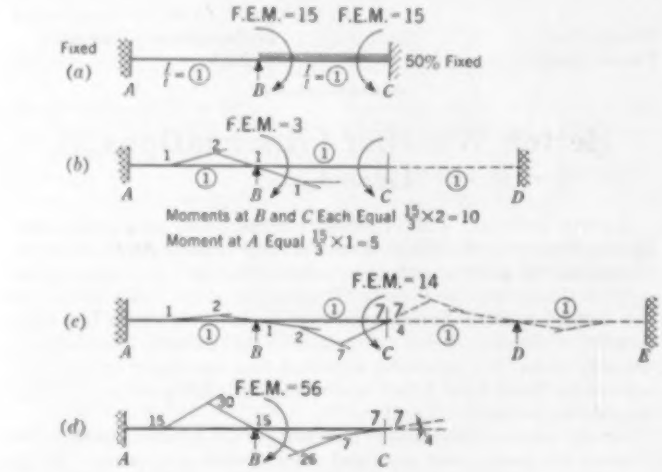
Inevitably one asks: Why this state of affairs? Don't our scientific departments know the difference between natural and partially artificial conditions? At best the long-time laissez-faire policy shown can but weakly be explained by the accessibility of the Federal Building site, the fact that the surrounding high buildings were erected one by one over a long period of years, and the further fact that modern observers were not familiar with any other type of observation site. Let me conclude with an amusing case from my own experience: Recently an observational site for Weather Bureau equipment on the ground with fairly good exposures was to be moved, as the government was about to add a high wing to the nearby Federal Building, and over the old Weather Bureau site. The architect and new Weather Bureau head carefully worked out a new site atop the new wing, and their plans were approved because "such sites are standard Weather Bureau practice." Alas and alack!

Rochester, N.Y. Ralph Z. Kirkpatrick

Distribution of Moments in Rigid Frames

TO THE EDITOR: In the February issue W. N. Suominen, Jun. Am. Soc. C.E., gives a solution by end-moment distribution of a two-span continuous beam which has a partial restraint, or partial fixation, of 50% at one end. This solution merits further consideration.

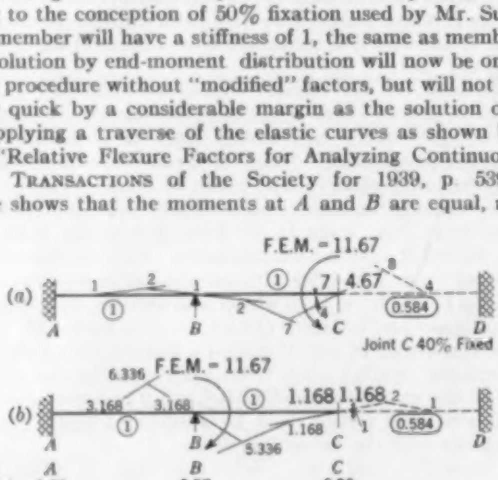
The accompanying Fig. 1 (*a*) shows the problem as stated, while Fig. 1 (*b*) shows the structure extended by an imaginary (dotted) member at the right end, the resistance of this imaginary member to bending to serve as the "partial restraint" at joint *C*.



	A	*B*	*C*
$\frac{15}{14}\times$ Fig. 1(*c*) =	1.07	2.14	7.50
$\frac{15}{56}\times$ Fig. 1(*d*) =	4.01	8.03	1.88
Final Moments	5.08	10.17	9.38

FIG. 1

According to the conception of 50% fixation used by Mr. Suominen, this member will have a stiffness of 1, the same as member *BC*. The solution by end-moment distribution will now be only the ordinary procedure without "modified" factors, but will not be as simple or quick by a considerable margin as the solution obtained by applying a traverse of the elastic curves as shown by Fig. 1 (*b*) ("Relative Flexure Factors for Analyzing Continuous Structures," TRANSACTIONS of the Society for 1939, p. 539). The traverse shows that the moments at *A* and *B* are equal, respectively, to one-third and two-thirds of the fixed-end moment at the right of joint *B*, or numerically equal to 5 and 10. This computation takes only a fraction of a minute and gives the same result as that obtained by Mr. Suominen.



	A	*B*	*C*
$\frac{15}{11.67}\times$ Fig. 2(*a*) =	1.29	2.57	6.00
$\frac{15}{11.67}\times$ Fig. 2(*b*) =	4.07	8.14	1.50
Final Moments	5.36	10.71	7.50

FIG. 2

The result, however, can be protested on the ground that it does not represent true 50% fixation at joint *C*. The reason for this is the fact that, although the I/l values of *BC* and *CD* are equal, their resistances to rotation at joint *C* are not equal due to the fact that *CD* is fixed at *D* while *BC* is only partially fixed at *B*.

To illustrate true 50% fixation at *C*, extend the structure two span lengths to the right, making it symmetrical about *C*. If a moment is now applied, as with a wrench handle, to the beam at *C*, as illustrated in Fig. 1 (*c*), half the resistance will be carried on each side of joint *C*. This may be considered true 50% fixation.

To solve Fig. 1 (*c*) run a traverse computation from *A* to *C* and, as the beam is symmetrical about *C*, turn the traverse about at *C* and continue it back to *B* as shown in Fig. 1 (*d*). The results are tabulated in the figure.

If the percentage of partial fixation at *C* were 40%, the traverse of the elastic curves would be asymmetric about *C* and could not be reversed in direction in the manner shown.

To illustrate a more general solution, let the percentage of fixation at *C* be 40%. Traverse from *A* to *C*, as shown in Fig. 2 (*a*). At *C* the moment measured by the angle 7 in span *BC* will be 60% of the fixed-end moment. The fixed-end moment at *C* will then be 11.67, and the moment in the imaginary span *CD* will be 4.67 as shown. Dividing the moment in span *CD* by its Δ angle, we find the necessary stiffness of span *CD* to be 0.584. Now construct Fig. 2 (*b*) illustrating a traverse from *D* to *A* and, by the same procedure as used for Figs. 1 (*c*) and 1 (*d*), tabulate the results showing below the figure.

Figures 1 (*c*) and (*d*) and 2 (*a*) and (*b*) exhibit the automatic check by Maxwell's theorem of reciprocal deflections, which is inherent in an elastic curve traverse computation.

RALPH W. STEWART, M. Am. Soc. C.E.
Engineer of Bridge and Structural Design, City of Los Angeles

Los Angeles, Calif.

DEAR SIR: In his article on "Partially Restrained Structural Members," in the February issue, Mr. Suominen states what the modified stiffness and carry-over factors should be for those members. The writer is unable to check the author's factors, except for the special case when $\overline{CO}_{AB}\,\overline{CO}_{BA} = 1/4$.

Using the author's notation, the writer will derive what he believes are more general coefficients. Apply K_A at *A* and hold *B* fixed. Then allow joint *B* to rotate, but hold end *A* fixed. The final moment at *A* is the modified K_A; the final moment at *B*, divided by the final moment at *A*, is the modified carry-over factor. See the accompanying tabulation.

	A		*B*: $1-f$	*B*: f
	K_A →		$\overline{CO}_{AB}K_A$	
	$-(1-f)K_A\overline{CO}_{AB}\overline{CO}_{BA}$ ←		$-(1-f)\overline{CO}_{AB}K_A$	$-f\overline{CO}_{AB}K_A$
Final Moments	$K_A[1-(1-f)\overline{CO}_{AB}\overline{CO}_{BA}]$		$f\overline{CO}_{AB}K_A$	$-f\overline{CO}_{AB}K_A$

For the special case that $\overline{CO}_{AB}\,\overline{CO}_{BA} = 1/4$, note that the author's answers apply. But there are many members for which $\overline{CO}_{AB}\,\overline{CO}_{BA}$ is not equal to $1/4$.

Cincinnati, Ohio. B. J. ALECK, Jun. Am. Soc. C.E.

Surveyor on Jag?

TO THE EDITOR: The illustration and poem entitled "The Last P. I.," which appeared on page 69 of the January issue, have inspired the following comment from an old transitman:

If he's running a curve
We feel bound to observe
There was plenty of nerve
In the guy.

Has he been on a jag
With his knees in a sag
And the smoke from his fag
In his eye?

A. C. D. BLANCHARD, M. Am. Soc. C.E.

Montreal, Canada

Spring Meeting in Baltimore, Md.

Lord Baltimore Hotel to Be Headquarters, April 23-25, 1941

Program of Meetings, Entertainment, and Trips

Opening Session and General Meeting

WEDNESDAY—April 23, 1941—Morning

8:00 **Registration**

Lord Baltimore Hotel is the headquarters for all sessions of the Spring Meeting.

10:00 **Spring Meeting called to order by**

F. A. Allner, *President, Maryland Section, Am. Soc. C.E.; President, Safe Harbor Water Power Corporation*, Baltimore, Md.

Addresses of Welcome

His Excellency Herbert R. O'Conor, *Governor of State of Maryland*, Annapolis, Md.

His Honor Howard W. Jackson, *Mayor of the City of Baltimore*, Md.

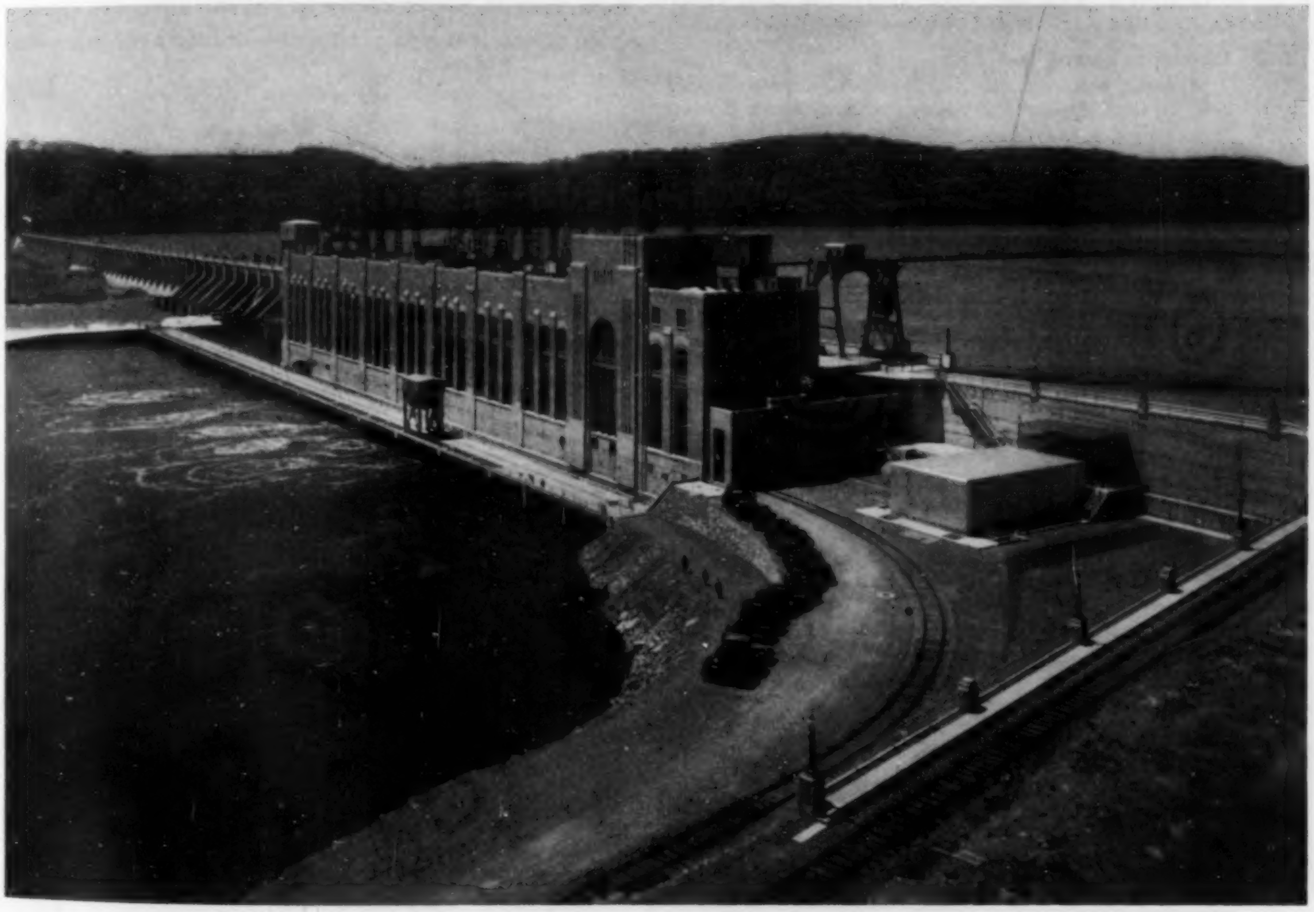
Response

Frederick H. Fowler, *President, American Society of Civil Engineers.*

11:00 **The Chesapeake Bay—Its Resources and Possibilities**

Abel Wolman, *M. Am. Soc. C.E., Professor of Sanitary Engineering, the Johns Hopkins University*, Baltimore, Md.

12:00 **Luncheon recess**



Safe Harbor Hydroelectric Plant on the Susquehanna River, Seen on Thursday Inspection Trip

See Page 31 (Advertising Section) for Advance Registration and Ticket Order Form.

Be Sure to See the April Issue of the "National Geographic Magazine" for a Most Interesting Article on Maryland, with Many Attractive Pictures of Points Included in the Program.

Afternoon Sessions of Technical Divisions

WEDNESDAY—April 23, 1941—Afternoon

ENGINEERING ECONOMICS DIVISION

E. B. BLACK, *Chairman, Executive Committee, Presiding*

2:00 Transportation of Tomorrow

HON. JOSEPH B. EASTMAN, *Chairman, Interstate Commerce Commission*, Washington, D.C.

2:30 The Economic Development of Transportation in the United States

J. E. TEAL, *M. Am. Soc. C.E., Transportation Engineer, The Chesapeake and Ohio Railway*, Richmond, Va.

3:00 Discussion

WATERWAYS DIVISION

WILLIAM G. ATWOOD, *Chairman, Executive Committee, Presiding*

2:00 Determination of Benefits Accruing to the Construction of Flood Control Works

E. W. DIGGES, *Assoc. M. Am. Soc. C.E., Senior Engineer (Civil), U.S. Engineer Office*, Baltimore, Md.

2:20 Discussion opened by

T. T. KNAPPEN, *M. Am. Soc. C.E., Consulting Engineer, Parsons, Klapp, Brinckerhoff and Douglas*, New York, N.Y.

2:30 Drainage of Leveed Areas in Mountainous Valleys

GORDON R. WILLIAMS, *Assoc. M. Am. Soc. C.E., Associate Hydraulic Engineer, U.S. Engineer Office*, Baltimore, Md.

3:00 Discussion opened by

MERRILL BERNARD, *M. Am. Soc. C.E., Supervising Hydrologist and Service Coordinator, U.S. Weather Bureau*, Washington, D.C.

3:10 The Toby Creek Pressure Conduit

J. THORNTON STARR, *Jun. Am. Soc. C.E., Assistant Engineer, U.S. Engineer Office*, Baltimore, Md.

3:30 Discussion opened by

CHARLES B. BURDICK, *Vice-President, Am. Soc. C.E. Consulting Engineer*, Chicago, Ill.

3:40 Pumping Problems Related to Flood Control

ROBERT T. REGESTER, *M. Am. Soc. C.E., Consulting Engineer*, Baltimore, Md.

4:00 Discussion opened by

FRANK A. MARSTON, *M. Am. Soc. C.E. Consulting Engineer*, Boston, Mass.

HIGHWAY AND CITY PLANNING DIVISIONS

R. W. CRUM, *Chairman, Executive Committee, Highway Division, Presiding*

2:00 Driver Behavior and Vehicle Performance

J. TRUEMAN THOMPSON, *M. Am. Soc. C.E., Professor Civil Engineering, The Johns Hopkins University*, Homewood, Baltimore, Md.

2:30 Military Roads

S. C. GODFREY, *M. Am. Soc. C.E., Colonel, Corps of Engineers, U.S.A., Chief, Operations and Training Section*, Washington, D.C.

Discussion opened by

WILLIAM N. CAREY, *M. Am. Soc. C.E., Consulting Engineer*, St. Paul, Minn.

3:00 National Defense Highway Through Maryland

EZRA B. WHITMAN, *M. Am. Soc. C.E., Consulting Engineer; Chairman, State Road Commission*, Baltimore, Md.

3:30 Discussion opened by

NATHAN L. SMITH, *Consulting Engineer*, Baltimore, Md.

STRUCTURAL DIVISION

SHORTRIDGE HARDESTY, *Chairman, Executive Committee, Presiding*

2:00 Unusual Design and Erection Problems in Aircraft Plant Expansion

PAUL TIGNOR, *Glenn L. Martin Company*, Middle River, Md.

2:30 Model Analysis—Susquehanna River Bridge

WILLIAM J. ENEY, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, Lehigh University*, Bethlehem, Pa.

3:00 Roofs Over the House and Senate Chambers of the U.S. Capitol

HERMAN F. DOELEMAN, *M. Am. Soc. C.E., Consulting Engineer*, Roland Park, Baltimore, Md.

3:30 Baltimore Airport

W. WATTERS PAGON, *M. Am. Soc. C.E., Consulting Engineer*, Baltimore, Md.

4:00 Discussion

YANKEE CLIPPER—BALTIMORE AIRPORT

HAVRE DE GRACE BRIDGE OVER SUSQUEHANNA RIVER

DINNER AND DANCE AT THE LORD BALTIMORE HOTEL

WEDNESDAY—April 23, 1941—Evening—7:00 p.m.

Tickets for the dinner and dance are $3.50 for men and $2.50 for ladies.
Tickets to the dance, available only to students, are $1.50 per couple.

Morning Sessions of Technical Divisions

THURSDAY—April 24, 1941—Morning

CONSTRUCTION DIVISION

H. O. Locher, *Chairman, Executive Committee, Presiding*

9:00 **Unique Design and Construction Features of the Potomac River Bridge at Ludlow Ferry, Md.**

H. H. Allen, *M. Am. Soc. C.E., Vice-President, J. E. Greiner Company,* Baltimore, Md.

9:35 **Discussion opened by**

C. M. Soule, *M. Am. Soc. C.E., Associate Engineer, J. E. Greiner Company,* Baltimore, Md.

Raymond Archibald, *M. Am. Soc. C.E., Senior Structural Engineer, Division of Tests, Public Roads Administration,* Washington, D.C.

W. H. Pahl, *Assoc. M. Am. Soc. C.E., Project Engineer, J. E. Greiner Company,* Baltimore, Md.

10:05 **National Defense Construction Work**

Thomas M. Robins, *M. Am. Soc. C.E., Brigadier-General, Corps of Engineers, U.S.A., Assistant to Chief of Engineers, War Department,* Washington, D.C.

10:40 **Novel Construction of a Large Venturi Meter**

Leon Small, *Water Engineer, Bureau of Water Supply Department of Public Works,* Baltimore, Md.

11:15 **Discussion opened by**

Gustav J. Requardt, *M. Am. Soc. C.E., Consulting Engineer,* Baltimore, Md.

POWER DIVISION

William P. Creager, *Chairman, Executive Committee, Presiding*

9:30 **Public Utility Financing—Recent Trends and Significant Factors**

W. C. Gilman, *Gilman and Hickey,* New York, N.Y.

9:50 **Discussion opened by**

Philip Sporn, *M. Am. Soc. C.E., Vice-President and Chief Engineer, American Gas and Electric Service Corporation,* New York, N.Y.

10:10 **Trends and Development of the TVA Power Program**

H. A. Wiersema, *M. Am. Soc. C.E., General Office Engineer, TVA,* Knoxville, Tenn.

10:30 **Discussion**

10:50 **Review of Model Tests of Hydraulic Structures for Safe Harbor and Holtwood Developments**

L. M. Davis, *Assoc. M. Am. Soc. C.E., Hydraulic Test Engineer, Pennsylvania Water and Power Crmpany,* Holtwood, Pa.

11:10 **Discussion opened by**

C. M. Allen, *M. Am. Soc. C.E., Professor of Hydraulic Engineering, Worcester Polytechnic Institute,* Worcester, Mass.

E. P. Schuleen, *Assoc. M. Am. Soc. C.E., Senior Engineer, U.S. Engineer Office,* Pittsburgh, Pa.

11:30 **General discussion**

SANITARY ENGINEERING DIVISION

Linn H. Enslow, *Member, Executive Committee, Presiding*

9:00 **The Activated Sludge Works at Baltimore, Maryland**

Robert T. Regester and Gustav J. Requardt, *Members, Am. Soc. C.E., Consulting Engineers,* Baltimore, Md

C. E. Keefer, *M. Am. Soc. C.E., Principal Assistant Engineer, Bureau of Sewers,* Baltimore Md.

9:30 **Water and Sewerage Problems of the Washington Suburban Sanitary District**

Harry R. Hall, *M. Am. Soc. C.E., Chief Engineer, Washington Suburban Sanitary Commission,* Hyattsville, Md.

Abel Wolman, *M. Am. Soc. C.E., Professor of Sanitary Engineering, John Hopkins University,* Baltimore, Md.

10:00 **Control of Pollution of Oyster Bearing Waters in Chesapeake Bay**

George L. Hall, *M. Am. Soc. C.E., Chief Engineer, State Department of Health,* Baltimore, Md.

10:30 **Discussion**

Trip to Hydro Plants at Holtwood and Safe Harbor

THURSDAY—April 24, 1941—Afternoon

Secure tickets at Registration Desk. Admission to plants restricted to U.S. citizens. No tickets sold on train.

Departure—1:30 p.m. by chartered electric train from Pennsylvania Station (on Charles Street, 15 blocks north from Convention Headquarters).

Return—9:00 p.m., Baltimore, Pennsylvania Station.
Tickets—$2.50, all inclusive.

For Wilmington, Philadelphia, and New York, connections can be made at Perryville, Md., arriving Philadelphia 9:38 p.m.; New York, Pennsylvania Station, 11:25 p.m. For northbound train connections, baggage may be checked through at Baltimore.

For Harrisburg, Pittsburgh, and points west, connection can be made by bus from Safe Harbor to Lancaster, Pa. Trains include "Trail Blazer," "Spirit of St. Louis," and "Manhattan Ltd."

Leaving Baltimore at 1:30 p.m., the train will pass the Glenn L. Martin airplane factory, Edgewood Arsenal, and cross the Susquehanna River at Havre de Grace. Arrival at Holtwood is scheduled for 3:00 o'clock. Here the trip will temporarily divide into two groups, uniting again at Safe Harbor by 6:00 p.m.

Group 1. Inspection of Power Plants at Holtwood and Safe Harbor

Group 2. Boat Trip on Lake Aldred to Indian Steps Cabin Museum

Group 1, after viewing the Hydro Station, the Hydraulic Turbine Laboratory, and the Steam Station at Holtwood, with its unique River Coal Recovery Plant, will proceed by train to Safe Harbor to inspect the power plant and exhibits which constitute a virtual museum. Buses will leave at intervals taking visitors to the Model Village and the Observation Site commanding an excellent view of the Safe Harbor Project.

Group 2, after arrival at Holtwood, will go by boat to the west shore of Lake Aldred, to the Indian Steps Cabin, a museum maintained by the York County Historical Society. This unique building, erected over 25 years ago by the late John Edward Vandersloot, of York, Pa., contains a valuable collection of Indian relics. This group will rejoin Group 1 at Safe Harbor about 6:00 p.m.

Supper will be served for both groups by courtesy of the Safe Harbor Water Power Corporation. The train will leave Safe Harbor at 7:30 p.m. for Baltimore, making connection at Perryville to the northbound "Arlington" of the Pennsylvania Railroad. Entertainment on the train and refreshments will be provided during the return trip to Baltimore.

Boat Trip on Chesapeake Bay to U.S. Naval Academy and Colonial Annapolis

Including Luncheon, Supper, Entertainment, Dancing

FRIDAY—April 25, 1941

Secure tickets at Registration Desk. No tickets sold at boat.

Departure—10:00 a.m. by chartered steamer "Mohawk" from Pier 6, Light Street (2 blocks east and 5 blocks south from Convention Headquarters).

Return—9:30 p.m., Pier 6, Light Street, Baltimore.

Tickets—$2.75, all iuclusive.

To connect with trains leaving Baltimore during afternoon or early evening please apply at Inspection Trip Desk at Registration Headquarters.

The combination of a boat trip on the blue waters of the Chesapeake Bay with a visit to quaint and historic Annapolis, capital of Maryland, should prove one of the most delightful events of the 1941 Spring Meeting—a beautiful setting for meeting old friends and making new ones. The boat, especially chartered for the occasion, is a comfortable propeller-driven excursion steamer with sufficient sheltered deck space to make the bay trip a pleasant one in all kinds of weather.

During the boat trip, excellent views may be had of the inner and outer harbor, Fort McHenry, Municipal Airport, Pan American Transatlantic Air Base, shipyards, docks, and the upper part of Chesapeake Bay. Off Fort McHenry, the birthplace of the "Star Spangled Banner," there will be a fire boat drill by the Baltimore City Fire Department.

Between 10:45 and 11:45 a.m., there will be presented an interesting discussion, illustrated by moving pictures, on the "Conservation of Chesapeake Bay Resources" by Edwin Warfield, Jr., Chairman, Maryland Conservation Commission, and by Dr. R. V. Truitt, Professor of Zoology, University of Maryland, and Director of the Chesapeake Biological Laboratory.

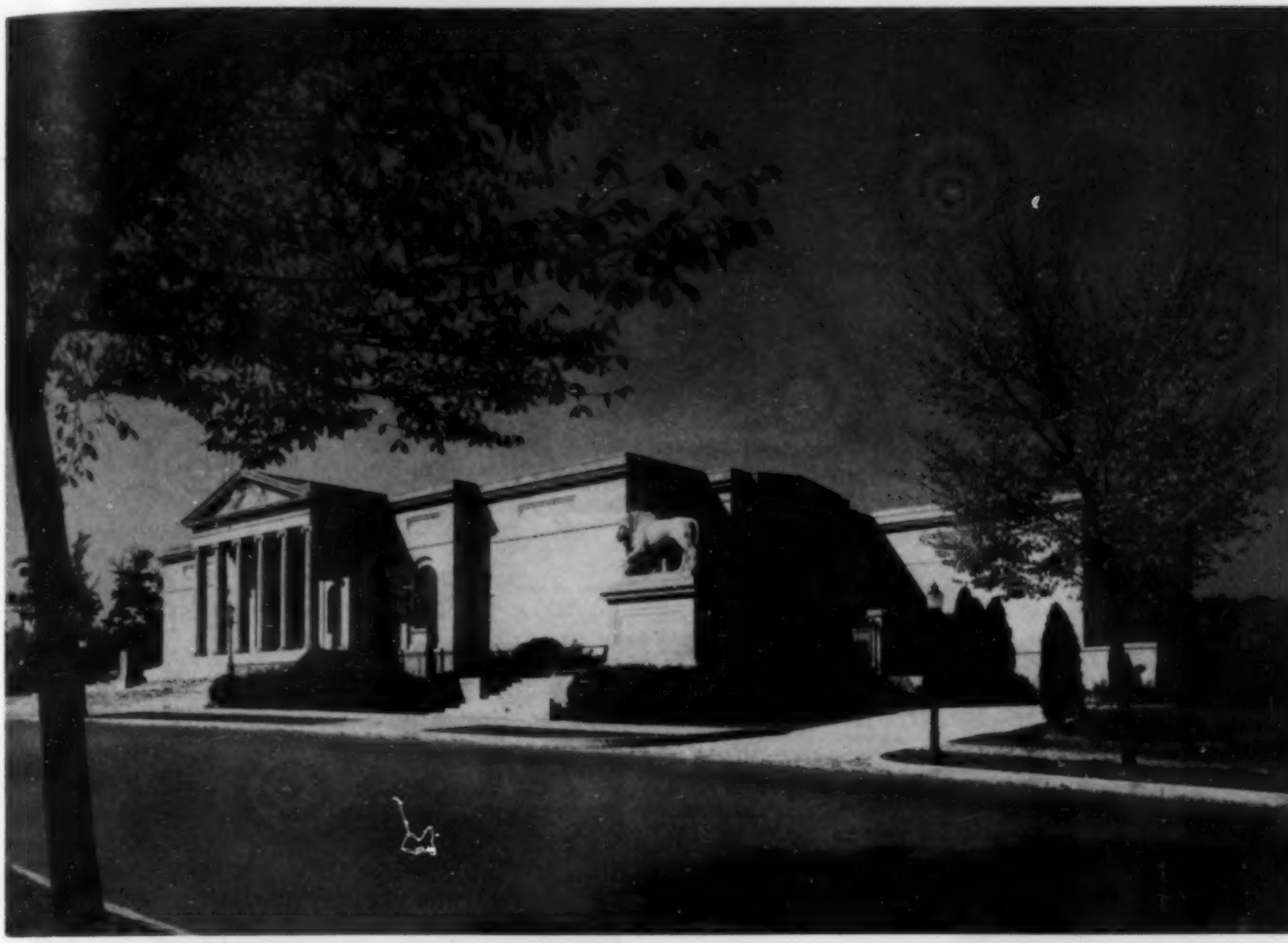
Following the moving pictures, a luncheon, featuring Chesapeake Bay sea food, will be served on board by one of Baltimore's best caterers.

At 1:00 p.m. the steamer will dock at Annapolis at the foot of King George Street immediately adjacent to the U.S. Naval Academy. Junior officers of the U.S. Naval Academy will conduct the visitors in small groups through the grounds and buildings, including Dahlgren Hall, the Naval Museum, the Chapel and Crypt, where repose the remains of the naval hero, John Paul Jones, and other points of interest. Boat and infantry drills and parades of the Midshipmen Battalions will be presented commencing at 3:30 p.m.

Through the cooperation of its custodian association, the famous Hammond-Harwood House will be opened to the Convention visitors. Built in 1774, this mansion is furnished throughout with heirlooms of that period. Other historic sites and buildings that will be seen during the stay at Annapolis are St. Johns College, founded in 1696, and the State House, with the old Senate Chamber where General George Washington resigned his commission as Commander-in-Chief of the Continental Army on December 23, 1783.

After departure from Annapolis at 6:00 p.m., supper and refreshments will be served on board. A lively orchestra in traditional plantation style will provide entertainment and music for dancing.

AIR VIEW OF UNITED STATES NAVAL ACADEMY, ANNAPOLIS, MD.



The Baltimore Museum of Art

Entertainment for the Ladies

Ladies Committee: Mrs. Ezra B. Whitman, *Chairman*, and Mrs. Margaret Ford, *Vice-Chairman*

WEDNESDAY—April 23, 1941

Visit to Walters Art Gallery, followed by Luncheon at Baltimore Country Club

Afternoon—Golf, Bridge, Sightseeing

11:00 Ladies will assemble at the Walters Art Gallery (corner Charles and Centre streets, six blocks north on Charles Street from Convention Headquarters).

Between 11:00 and 12:00 noon, several lecture tours will be conducted by curators of this internationally known gallery, now owned by the City of Baltimore. Visiting ladies will meet the local ladies at the gallery.

Transportation by bus and private cars to the luncheon at the Baltimore Country Club.

12:30 Luncheon at Baltimore Country Club in honor of Mrs. Frederick Hall Fowler. Bridge or golf will follow for those who care to stay at the Club. The others will be taken about the city on individual sightseeing trips by the local ladies to see Fort McHenry, museums, parks, and other points of cultural and historical interest.

All ladies are invited to visit, at 3:45 p.m., the plant of McCormick and Company (Light and Barre streets), importers and exporters of tea and spices, and have tea at "Ye Olde McCormick Tea House."

Complimentary to visiting ladies. Reservations close 8:00 p.m., Tuesday, April 22.

7:00 **Dinner and Dance at the Lord Baltimore Hotel**

Tickets $2.50, all inclusive (see special notice).

THURSDAY—April 24, 1941

Morning

10:00 **Harbor Inspection Trip by Boat or Sightseeing** (See Special Notice)

Afternoon and Evening

1:30 Excursion on chartered electric train to Holtwood and Safe Harbor; boat trip to Indian Steps Cabin Museum. Supper at Safe Harbor. Entertainment and refreshments on the return trip to Baltimore.

Transportation has been arranged to connect with trains leaving Baltimore earlier in the evening (see special notices).

Tickets $2.50. All inclusive (see special notice elsewhere).

FRIDAY—April 25, 1941—All Day

Chartered Boat Trip to U.S. Naval Academy and Colonial Annapolis

Members, ladies, and guests will embark for Annapolis at 10:00 a.m. on the chartered steamer *Mohawk*.

See special notice elsewhere for details.

Luncheon, supper, entertainment, and dancing. Tickets $2.75, all inclusive.

Program of Student Chapter Conference

WEDNESDAY—April 23, 1941—All Day

Morning

Registration at Johns Hopkins University, Charles and 34th Streets, Baltimore, Md.

JOHN H. PORTER, *Committee on Student Chapters, Am. Soc. C.E., Chairman*

G. JACKSON BAUER, *President, Johns Hopkins University Student Chapter, Presiding*

Address of Welcome

DR. ISAIAH BOWMAN, *President of the Johns Hopkins University*

Business Meeting

Address on "The Care, Feeding, and Rearing of an Infant Industry," DR. RALPH LEE, *Public Relations Department, General Motors Corporation*, Detroit, Mich.

Luncheon at Levering Hall (on Campus)

Tickets 50 cents each.

Afternoon

Bus Trip to Chevrolet Motor Company's Plant near Baltimore

Evening

Dinner at Levering Hall

DR. ABEL WOLMAN, *M. Am. Soc. C.E., Professor of Sanitary Engineering, the Johns Hopkins University,* will act as toastmaster.

The principal speaker will be DR. HENRY CLAY MCCOMAS, formerly Professor in Psychology at the Johns Hopkins University. Dr. McComas will relate his wide experiences in exposing spiritualists. In this connection he has been retained on a number of occasions by organizations interested in psychic research to attend and report on seances.

Tickets $1.00 each.

Dance at the Lord Baltimore Hotel

Tickets $1.50 per couple.

THURSDAY—April 24, 1941—Morning and Afternoon

Morning—Students will participate in Technical Sessions of Spring Meeting

Afternoon—Trip to Safe Harbor Hydroelectric Plant. Student tickets $1.50 each.

(See statement elsewhere for details.)

SPILLWAY OF PRETTYBOY DAM
Baltimore Water Supply

DOWNTOWN BALTIMORE AND VIEW OF
SHIPPING IN UPPER HARBOR

Hotel Accommodations and Announcements

Baltimore Harbor Inspection Trips by Boat

WEDNESDAY and THURSDAY—April 23 and 24

Morning and Afternoon

By the courtesy of the City of Baltimore and its Harbor Engineer, two boat trips per day are scheduled for Wednesday, April 23, and Thursday, April 24. The boat will leave at 10:00 a.m. and 2:00 p.m. from the foot of Calvert Street (3 blocks east and south from the Convention Headquarters). As accommodations are limited to 30 persons per trip, reservation must be made at the Inspection Trip Desk at Convention Headquarters. Approximately two hours are required for the tour of the harbor.

The afternoon trips will terminate at the Light Street pier opposite the plant of McCormick and Company, Inc., old established importers and exporters of tea and spices. Tea will be served at "Ye Olde McCormick Tea House."

Individual and Group Inspection Trips

For information on individual and group inspection trips to industrial plants, engineering projects, museums, art collections and other points of cultural and historical interest, please apply at Inspection Trip Desk.

Exhibits

Interesting Models, Instruments, Pictures and Maps Will Show Various Phases of the Civil Engineer's Work

The City of Baltimore will provide models and pictures of its water supply and sewage treatment works. The state, in cooperation with the U.S. Bureau of Public Roads, will exhibit maps, pictures, traffic surveys, and comparative data on Maryland's road system.

The colored moving picture "Baltimore," with comments by Lowell Thomas, will be shown continuously as one of the feature exhibits. This beautiful movie requires about thirty minutes for presentation but can bring to the audience more information than they could hope to obtain in many hours of travel in and around Baltimore.

From the federal government will be obtained exhibits of the work of a number of its agencies—the Forest Service, Bureau of Reclamation, and the Geological Survey. The latter will show equipment and pictures of its experimental work being carried out in cooperation with the Maryland Geological Survey.

The U.S. Engineer Office has brought together an exhibit showing equipment and methods for seismographic exploration of foundation conditions. It will also demonstrate working models of navigation and flood-control structures. An unusual exhibit will be a short movie, in animated cartoon style, showing the progressive building up of the discharge of the tributaries and main river during the 1936 record flood on the Susquehanna.

The Pennsylvania Turnpike Commission has lent still and moving pictures of its new super-highway.

The exhibits of the Baltimore and Ohio Railroad will emphasize the evolution of bridge trusses and railroad rails. Models of their locomotives and equipment, comparing old and modern designs, will also be on display.

The Glenn L. Martin Company will show the development of another field of transportation. Their models of airplanes and of their plants call attention to the growth of a rapidly expanding industry.

There has been brought from Safe Harbor, objective of the inspection trip on Thursday afternoon, a sectional model of this hydroelectric development. The model shows in exact detail the structural design and the electrical and mechanical equipment of a modern power plant.

Hotels and Rates

Hotel	Single Rates	Double Rates
Lord Baltimore, Baltimore Street at Hanover	$3.00 up	$5.00 up
Belvedere, Charles Street at Chase	3.50 up	5.50 up
Emerson, Calvert and Baltimore streets	3.00 up	4.50 up
Maryland, 20 East Fayette Street	2.00 up	3.50 up
New Howard, 8 North Howard Street	2.50 up	4.00 up
Southern, Light and Redwood streets	3.00 up	5.00 up
Stafford, Charles Street and Madison	3.00 up	5.50 up

Headquarters of the Spring Meeting will be at the Lord Baltimore Hotel.

In order to be certain of accommodations, members are urged to make reservations for rooms directly with the hotel of their choice, at least one week ahead of the date of the meeting.

All who attend the Spring Meeting are requested to register at Headquarters immediately upon arrival. Special badges and tickets will be obtained at the time of registration.

Order All Tickets in Advance

Members who order tickets in advance will not only be saved delay by having tickets and badges awaiting them on arrival at Headquarters, but they will assist the Committee greatly by giving advance information to guide it in concluding arrangements.

Information

An information desk will be provided in the Headquarters Hotel to assist visiting members in securing desired information about the city. At the registration desk a card file of those in attendance will be maintained, with information as to Baltimore addresses.

Efforts will be made to deliver telegrams and messages promptly. Any mail for members received at Convention Headquarters during the meeting will be delivered to the hotel address, if known; otherwise, it will be held at the Convention Information Desk. Letters undelivered at the close of the meeting will be forwarded to latest mailing address.

The Transportation Committee will make railroad and pullman reservations and will have available information on automobile, bus, boat, and air travel from the city. Requests for reservations and travel information should be made at the special Transportation Desk.

Entertainment for the Ladies

Attention is directed to the entertainment provided for the ladies. It is expected that they will participate with the members in any other features of the program in which they are interested.

Facilities of Engineers Club

The Engineers Club of Baltimore, located at 6 West Fayette Street, just one block from the Convention Headquarters, will be glad to extend the use of its facilities for lunch and recreation to the visiting members of the Society.

Local Sections Conference, Tuesday, April 22, 1941

A conference of representatives of Local Sections will meet at 9:30 a.m. on Tuesday, April 22, 1941, at the Lord Baltimore Hotel. The program will schedule topics of professional rather than technical interest, in which all representatives are expected to participate. All members of the Society are welcome to attend.

Junior Luncheon, Wednesday, April 23, 1941

There will be a luncheon for ocal and visiting Juniors on Wednesday, April 23, 1941, at 12:30 p.m. (place to be announced). Tickets 50 cents each. Please secure tickets early at Registration Desk.

Student Conference, Luncheon and Dinner
Wednesday and Thursday, April 23, and 24, 1941

Members of Student Chapters are invited to participate in all events of the Spring Meeting. Particular attention is called to the program of the Student Conference on Wednesday, the luncheon and dinner on Wednesday, and the trip to Safe Harbor on Thursday. See details elsewhere in this program.

Local Committees on Arrangements

Executive Committee

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F. A. ALLNER, *Vice-Chairman*
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Entertainment Committee

S. BOYD DOWNEY, *Chairman*
SAMUEL L. THOMSEN, *Vice-Chairman*

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G. R. WILLIAMS, *Vice-Chairman*

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H. A. LANE, *Vice-Chairman*

J. FISHER, J. V. HOGAN, R. LACY

Inspection Trips Committee

J. M. MOUSSON, *Chairman*
C. E. KEEFER, *Vice-Chairman*

R. L. BURWELL, R. W. CHASE, A. F. DI DOMENICO, D. W. FRY, J. C. GEYER, C. R. JOHNSON, F. M. KIPP, JR., F. KNOOP, R. L. MCCOY, A. C. SPENCER, A. E. STEERE, A. C. THOMAS, W. W. TROXELL, H. L. VINCENT, F. C. WACHTER, F. G. WRIGHTSON, JR.

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J. M. COAN, JR., *Vice-Chairman*

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T. F. COMBER, JR., *Vice-Chairman*

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J. M. RUSSELL, *Vice-Chairman*

D. L. B. FRINGER, G. L. HALL, R. MATHER, E. B. RIDER

Speakers Before Civic Clubs Committee

R. M. REINDOLLAR, *Chairman*

J. H. ENSEY, H. G. PERRING, F. L. REED, G. C. SAUNDERS

Reception Committee

E. B. WHITMAN, *Chairman*
H. F. WILDS, *Vice-Chairman*

L. F. BELLINGER, F. C. BOGGS, P. A. COHEN, C. A. CUMMINS, V. S. DOEBLER, H. F. DOBLEMAN, F. H. DRYDEN, J. B. FERGUSON, G. E. FINCK, P. J. FLANIGAN, JR., T. W. HACKER, F. A. KUMMER, C. H. LOCHER, A. M. QUICK, N. L. SMITH

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S. S. STEINBERG, *Vice-Chairman*

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Ladies Committee

MRS. EZRA B. WHITMAN, *Chairman*
MRS. MARGARET FORD, *Vice-Chairman*

MRS. HERSCHEL H. ALLEN, MRS. FREDERICK A. ALLNER, MRS. WILSON T. BALLARD, MRS. THOMAS F. COMBER, JR., MRS. HOWARD L. CRANDALL, MRS. EDWARD W. DIGGES, MRS. EDWARD J. DOUGHERTY, MRS. S. BOYD DOWNEY, MRS. GEORGE E. FINCK, MISS GLADYS H. GREINER, MRS. PAUL L. HOLLAND, MRS. THOMAS F. HUBBARD, MRS. JOSEPH W. JONES, MRS. HERBERT IDE KEEN, MRS. NORMAN D. KENNEY, MRS. EDWARD M. KILLOUGH, MRS. JOSEPH K. KNOERLE, MRS. HARRY A. LANE, MRS. EDWARD S. LOANE, MRS. J. MARCUS MOUSSON, MRS. WALTER D. MYERS, MRS. W. WATTERS PAGON, MRS. HENRY G. PERRING, MRS. STEUART PURCELL, MRS. ROBERT T. REGESTER, MRS. ROBERT M. REINDOLLAR, MRS. GUSTAV J. REQUARDT, MRS. JOHN M. RUSSELL, MRS. DONALD H. SAWYER, MRS. J. TRUEMAN THOMPSON, MRS. SAMUEL L. THOMSEN, MRS. JOHN A. WALLS, MRS. HOWARD F. WILDS, MRS. GORDON R. WILLIAMS, MRS. ABEL WOLMAN

The program as a whole has been prepared under the direction of the Spring Meeting Committee, composed of CHARLES H. STEVENS, *Vice-President, Am. Soc. C.E., Chairman;* and CLIFFORD G. DUNNELLS, ARMOUR C. POLK, GUSTAV J. REQUARDT, and SANFORD W. SAWIN, *Directors, Am. Soc. C.E.*

Please call on the Local Committee on Arrangements or on the Secretary's office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

The Society and Civilian Protection

Some of the Real Accomplishments in a New and Difficult Field

By WALTER D. BINGER, M. AM. SOC. C.E.

COMMISSIONER OF BOROUGH WORKS, BOROUGH OF MANHATTAN, CITY OF NEW YORK, N.Y.; CHAIRMAN OF NATIONAL COMMITTEE ON CIVILIAN PROTECTION IN WAR TIME

THE ORGANIZATIONAL stage of the Society's National Committee on Civilian Protection in War Time lasted from five to six months. It has now been completed. That period, however, was not by any means devoted solely to organization, for real results were obtained.

It must be recalled that knowledge on air-raid protection in this country came principally through newspaper articles and photographs of the German air blitzkrieg on England. A cursory examination showed that little authoritative information was available. At the time the work was initiated, the situation was merely that the Society as an institution, and its members as individuals, felt that civil engineers had a great deal to offer, but no definite procedure had been outlined and no specific steps taken. Apparent, too, were vital differences between the situation in England and that in the United States, which, if not understood at the outset, might later cause great loss of time and effort.

Perhaps not generally known is the fact that the protection of civilians in war time, as a responsibility independent of the Army's fighting activities, had not been considered a function of the War Department until last spring. There was then organized a "Civil Defense Branch" of G-3, the Operation and Training Division of the General Staff. Heretofore the Army protected civilians in a combat zone or evacuated them. Civilians elsewhere required little or no protection and shifted for themselves. It is important to have this in mind to realize the scope and novelty of the problem.

The War Department was approached, but in spite of the favorable auspices under which the first conference was held, it appeared that the Army staff representatives present had grave doubts as to whether civil engineers could really be of much help, or whether a formal connection between the two was feasible. Still, the informal contact was pushed to the limit, with the result that the feeling of mutual dependence grew rapidly. A strange situation then arose. The War Department became so well "sold" on the idea that this problem was really a civilian one, that the opinion was frequently expressed that it should step out altogether and leave the matter to some such agency as the Department of Interior, which appeared most nearly analogous to the British Home Office. At this time we introduced a statement of principle that was used so often it was almost worn out: "We civil engineers can tell how to protect civilians and their works only if you tell us what kind of a war it is going to be." In other words, what are the characteristics of the bombs and their explosive action? Will gases be used and, if so, how? What actually has happened and is happening abroad? These and all other similar questions can be answered only by the War Department. Those officers and civilian executives who were to have most to do with establishing the formal relationship between the Committee and the War Department came to accept the idea that passive protection was a civilian activity under War Department guidance.

During all this time a vigorous attempt was made to find out just what was the basic problem of civilian protection. No committee appointments had been made, since it seemed that functions were then more important than men. Before long it had been decided that there were five categories into which the whole subject of the civil engineering part of civilian protection could be divided, and no work was found that did not logically fall under one of those five categories. An organization chart was made, complete in its principal details but without the names of men. The types of mind and training needed were learned from it, and able men willing to do the arduous work required were readily found to constitute the National Committee. (The final chart appeared in CIVIL ENGINEERING for February 1941, page 125.)

After the very first meeting of the National Committee it was realized that an identical group should be appointed in each of the 64 Local Sections. As this article goes to press 52 Sections have appointed parallel committees of 6 men each, and there are therefore at least 312 able engineers studying the complex problem.

Although 90% of the work seemed to be civil engineering, it was clear that the remainder required training that civil engineers in general would not have. This conclusion was reached through a study of the known requirements. For example, a functional study of an air-raid shelter reveals a structure (civil engineering) designed to house numbers of people in close confinement (public health), perhaps proof against, and properly placed to resist, gas (chemical engineering), with proper ventilation and air conditioning (heating and ventilating), connected with, but independent of lighting (electrical engineering), not to mention various other characteristics. It was then decided that the Society should outline a plan of organization to the War Department. Functional charts for population movement, air-raid shelters, water supply protection, and other functions, were presented, together with a master chart in which the functions were plotted against the groups that would have to be responsible for their study. With intelligent and sympathetic cooperation, the War Department created the National Technological Civil Protection Committee, consisting of one member from each of the following national societies: American Society of Civil Engineers (Chairman), American Society of Heating and Ventilating Engineers, American Water Works Association, American Institute of Chemical Engineers, American Public Health Association, American Society of Mechanical Engineers, American Gas Association, American Institute of Architects, American Institute of Mining and Metallurgical Engineers, American Railway Engineering Association, American Institute of Electrical Engineers, and a contact member from the War Department.

Now as to actual results. In formulating the National Technological Civil Protection Committee, the Secretary of War issued a published statement in which, among other definitions, he stated that it was the Committee's function "to assist the War Department in technical matters relating to the collection, evaluation and dissemination of information of value in the protection of civilians and vital civilian installations in time of war." Acting upon this, a suggestion was made to the War Department that it refrain from publishing any material on civilian protection without submitting a draft to the National Technological Committee for study by its constituent groups. The Department was assured that if the Committee's recommendations were accepted there would be such a preponderance of engineering authority behind the publication as to render it safe from effective criticism.

The first publication, on "Protective Construction," was produced as a result of that collaboration. Because it was mainly devoted to structures, the work of criticism was handled by the American Society of Civil Engineers group. In this publication, criteria for design against stupendous impact and explosion are given to the practicing American civil engineer for the first time. To be sure, the treatment is largely of an empirical rather than of a theoretical nature, but anyone who takes the trouble to examine even recent specialized design will find that there is nothing startlingly new in that. The booklet should therefore constitute a satisfactory guide for the application of engineering judgment.

An important document on "Gas Defense," and others on

"Blackout" and "Fire Protection," similarly sponsored, are about to make their appearance.

Answers to vital questions pertaining to the protection of essential installations and to recorded results of bombing have been brought back from England by the War Department's Contact Member on the National Technological Committee. Except in limited cases where such information has been declared secret by the War Department, this material has been sent to all the Local Section Committees. Further information has been made available to them through a growing bibliography assembled and already put to considerable use by the National Committee of the Society.

Our five National Committeemen have commenced to open up a two-way path for the flow of ideas between themselves and the Section Committees, and this seems the basic essential for success. They have tried to state their respective problems, and though each would be the first to admit that he had not been completely uccessful, there is no doubt that the conception of these problems is now far clearer than it was even a month ago. They must be further evaluated and developed by the Section groups, each according to its own special circumstances. We know the temptation to feel the need for making the sparks fly as soon as work of this kind is understood, but a good deal of thought and discussion ought to precede activity.

Available space does not permit of a more complete description of specific work under way in the five categories—of the classification of water works, the plotting of roads paralleling the military highways, and similar measures. The subject, which is an aggregation of many details, could be set forth only by marshaling them in volume.

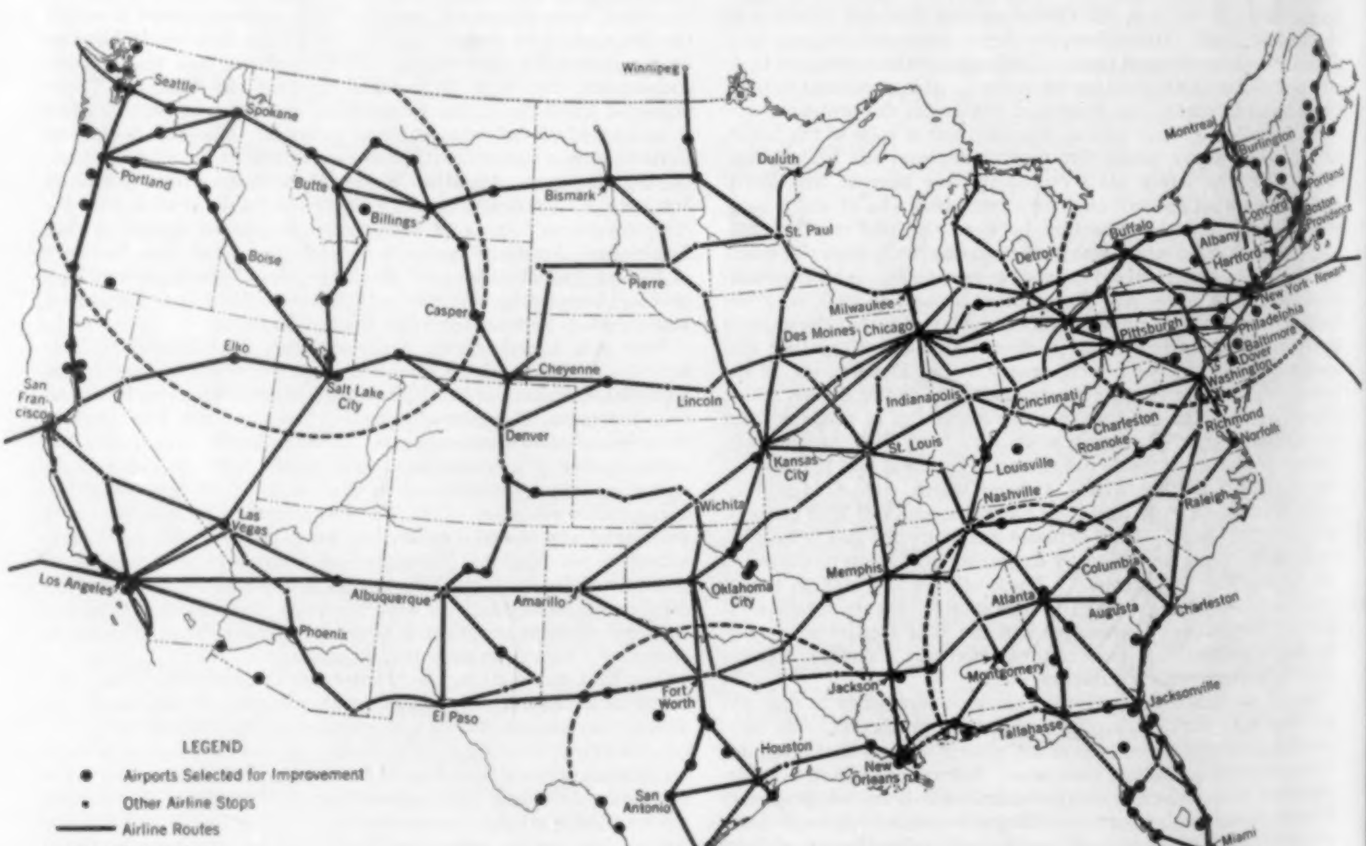
I should like to emphasize that the Committees for the Protection of Civilians in War Time, whether National or Local Section, have no authority and desire none. They have been organized to create a source of engineering information and to develop engineering ideas into a new technology. Such recognition as they will get, and such calls for greater service, will flow directly from their success along these lines. The constituted authorities will turn to them. There will be no one else.

National Defense Stimulates Construction of Civil Air Fields

Forty-Million-Dollar Congressional Appropriation Initiates Program

OF THE 200 civil airports recently selected for improvement because of their military value, 188 are in the continental United States. Sites were selected by the Civil Aeronautics Authority Board consisting of the Secretaries of War, Navy, and Commerce. The Corps of Engineers is charged with design and construction. Improvements will consist of grading runways, lighting, and drainage. The appropriation may not be used for land acquisition or for buildings. An additional appropriation by the current Congress is expected. Col. Donald H. Connolly, M. Am. Soc. C.E. is Civil Aeronautics Administrator.

The map appearing herewith shows the airports selected for improvement, other airline stops, etc. It is from the February issue of *National Aeronautics*, and is reproduced through the courtesy of the National Aeronautics Association.



Short Subjects, Field Details, Needed for CIVIL ENGINEERING

Young Men Close to Job Urged to Submit New Wrinkles, Construction Short Cuts, or Useful Experiences for Publication

IT IS BELIEVED that busy field men often fail to realize the interest that others would have if they were to know of the many small—and sometimes big—details that arise and are overcome in connection with construction work. The Committee on Publications would like to call the attention of younger men out on construction to the desirability of telling briefly of such experiences. There is a definite place in CIVIL ENGINEERING for write-ups describing ingenious expedients that have helped to save time, improve workmanship, or overcome temporary handicaps.

There are innumerable techniques and ingenious devices that should be given freely to the profession. For example, have you found that a hand-tamping plate with rounded edges is superior to one with sharp edges? What do you use for bench marks in laying out forms in the upper levels of a high office-building job? Have you worked out any particular favorite design for anchor pickets or deadmen to which to tie your tower guys? It is true that patented devices (unless dedicated to the public) or subjects of commercial interest may not be advertised thus indirectly by the Society. But avoiding that, what are the devices or experiments that you yourselves or your associates have worked out to make the job more efficient?

If these suggestions carry no inspiration, perhaps you have been more interested in developing gadgets to make your power tools more automatic, self-lubricating, faster, or safer? Have you found a way to keep one eye on water in the concrete, one on the cement, one on the reinforcing steel, and two on the construction joints—all at the same time? Is there a simple way to keep ice out of the sheaves? Can personnel efficiency be improved by keeping a pot of coffee in a bucket of hot rivets?

Simple expedients developed during progress of the work have many times dissolved the most troublesome handicaps. An improvised hangar for fixing anchor bolts in position as a footing is poured, a bar-spacer for odd-shaped forms, a handy rest for a heavy "portable" power drill, and an unusual catwalk suspension would be examples of subjects that could be profitably offered for a brief space allotment.

The developments that belong in these categories are endless. Some will require more room than others for description. Very short subjects are appropriate to the Engineers' Notebook section while main articles in CIVIL ENGINEERING carry nominally from 1,500 to 3,200 words. Photographs, or occasionally a sketch, are all-important in conveying to the reader a sense of the reality of the words.

May we suggest to those who have not yet tried their skill at authorship that to develop facility in writing there is nothing so useful as writing; and that, for beginning, there is no time sooner than today.

If an idea is worth putting into practice, it should be worth telling about.

Committee on Engineering Education to Pursue Broad Program

THE WORK of the Society's Committee on Engineering Education has now progressed to the point where a detailed statement of its aims is appropriate. At the request of the present chairman, Prof. Thomas C. Adams, and with the approval of the Committee, Dean Samuel B. Morris (chairman in 1940) presents the five specific objectives adopted by the 1940 Committee for its guidance:

1. To bring to the attention of the American Society of Civil Engineers significant developments in engineering education, especially civil engineering, and the governing and advanced viewpoints regarding these, and to create among members of the Society the concern and interest in these matters which their importance warrants.

2. To assist in coordinating the views of educators and engineers in other professional practice concerning the methods, objectives, powers, and opportunities of civil engineering education to the end that there may be joint effort to improve civil engineering education and adapt it to the needs of students and the profession.

3. To aid in preserving the high technical and professional character of engineering education so that it may continue effectively to contribute to the advancement of the civil engineering profession.

4. To aid in stimulating the appreciation of the scientific and mathematical character of civil engineering instruction and in keeping that instruction in a position of leadership in science and technology that will render it competent to increase its influence on vitally important economic and social progress.

5. To suggest measures to assist civil engineering departments and schools in obtaining the material and moral support, and the alert, well-trained scholarly and broadly comprehending personnel they need to assume leadership in engineering education.

These aims the Committee proposes to translate into action through study and reports dealing with (a) civil engineering curricula, (b) general theories and objectives of engineering education, (c) coordination of educational aims and practice between different engineering groups and branches of engineering practice, (d) college preparatory training for engineering students in both public and private secondary schools, (e) plans for selection and guidance of students and prospective students, and (f) proposals for post-graduation educational guidance.

Spring Meeting Preparations

IF INTENSITY of preliminary activity by the program committees is significant, the Baltimore Meeting schedule will give the visitor a feeling of compressing a year of postgraduate courses, a summer of inspection trips, and a commencement week of social events into three sleepless days (and/or nights). Arrangements for entertainment were nearly completed by the latter part of March, and indications at that time were that technical papers were being rounded out well in advance of dead lines. As the schedule on preceding pages indicates, the subjects represented promise to be timely and stimulating without exception.

From all of this the conclusion to be drawn is that the Spring Meeting will return with generous interest all expenditures of time and effort by engineers in attending.

Daniel W. Mead Prize Competition

POSSIBLE competitors are reminded that the 1941 competition for the Daniel W. Mead Prizes for student and for Junior papers in the field of ethics will close on July 1, 1941. It will be recalled that to be eligible for entry in the competition, such papers must have been presented at a meeting of an appropriate group—student papers before a Student Chapter, a Chapter Conference, or a Local Section; and Junior papers before a Local Section or a Local Section Conference.

As far as practicable, competitors are requested to submit their entries in the form of six copies, but inability to provide the multiple copies should not prevent or delay any entry. The rules for the competition are printed in the Yearbook of the Society, or a copy will be furnished on request.

The topic for the student prize paper is "Ethics of the Engineer Inspector," and that for the Junior prize paper, "Ethics of Junior Construction Engineers."

Lantern Lectures Revised

THE Society's lantern lectures on the construction of the Morris Dam and the Wheeler Dam in the Tennessee Valley have been revised in the light of progress since they were first prepared. These lectures are again back on the active list, available to Student Chapters—and to Local Sections after Chapter requirements are satisfied. There are now 23 lectures in the Society series, each complete with a talk keyed to the slides. The rest of the list was published in the December 1940 issue of CIVIL ENGINEERING.

Defense News

SECRETARY of War Stimson announces that, beginning July 1, special courses to train 2,000 commissioned officers annually will be opened to enlisted men, including Selective Service trainees. Four successive courses will be operated, each lasting three months, with 500 students in each course.

The training courses will be initiated July 1 with 200 men at Fort Benning, Ga., Infantry School; 50 at Fort Riley, Kans., Cavalry School; 125 at the Field Artillery School, Fort Sill, Okla.; and 125 at the Coast Artillery School, Fort Monroe, Va. Later in the fall, October 1, an Engineer School is contemplated at Fort Leonard Wood, Rolla, Mo.

To be eligible, enlisted men must have had six months of active field service with at least three months of unexpired enlistment. To provide for commissioning Selective Service trainees, the maximum age limit has been lifted from 30 years to 36 years.

* * * *

Director of Selective Service, C. A. Dykstra, urges all registrants for Selective Service to advise their local boards promptly in case of change of address. The Selective Service regulations provide penalties for failure to respond to a summons, which Dr. Dykstra hopes need not be imposed, because of the inability of the Postmaster to find the selectee.

* * * *

The Division of Coordination of National Defense Housing has been placed by Executive orders in the office for Emergency Management of the Executive Office of the President. C. F. Palmer, Defense Housing Coordinator, has requested through the President a new Congressional appropriation of $150,000,000 for a new Defense Housing program, and an additional appropriation of $75,000,000 for financing the remainder of the program authorized at the last session of Congress.

* * * *

The President has approved the construction of 3,600 more defense houses in 27 areas, bringing the total number of dwellings for which public funds have been allocated as of March 1, 1941, to 72,000 units in 253 projects. Thirteen of the new projects have been assigned by Federal Works Administrator John Carmody to the Public Buildings Administration and five to the United States Housing Authority. The Federal Works Agency reports under construction 22,000 dwelling units estimated to cost $69,000,000.

The Public Buildings Administration handles its own designing and supervision and negotiates contracts for the construction of the defense housing projects assigned to it. The U.S. Housing Authority now operates through local housing authorities, which contract for the design and some of the supervision and for the construction.

* * * *

The Navy has announced the award of contracts by the Bureau of Yards and Docks for construction of Navy bases at Newfoundland, Bermuda, Jamaica, Trinidad, Antigua, St. Lucia, and British Guiana. Contracts for the construction of the Army bases at these points have been awarded by the Chief of Engineers.

* * * *

Hand in hand with the huge national defense program comes the necessity for accommodations for families of men engaged on it. First comes the defense housing program now under construction to house the families of workmen in industrial plants, and the families of enlisted personnel on or near Army and Navy posts and camps. The second $150,000,000 appropriation bill for defense housing (Lanham Act) has been passed by the House. Second, comes the additional load on the community utilities due to the influx of population. Congress has been asked for $150,000,000 for construction of new municipal water supply, sewage disposal, and additional streets in locations where defense necessity is declared to exist. Third, the influx of families is taxing the school facilities near Army and Navy reservations. Congress has before it a request from the Office of Education for funds to furnish shools wherever necessity for them is declared. (For additional details see page 260.)

Far-reaching implications relative to engineering and construction activities are contained in the history-making legislation recently introduced in Congress. Although the measures are familiar

ARMY DEFENSE CONSTRUCTION PROJECTS UNDER WAY

A Half-Million Men Are at Work on 225 Projects for Housing, Equipping, and Training the Authorized Army of 1,400,000. The Total Cost Will Be Over a Billion Dollars

to everyone, it may be wise to summarize the four major acts here.

The Lease-Lend Bill was passed on March 11, and became law when it was signed by the President the same day. This was immediately followed by a Presidential request for $7,000,000,000 to implement aid to England to the greatest extent. Ordnance, armor, tanks, automotive vehicles, aircraft, ships, facilities for the manufacture of all these items, and foodstuffs compose the items proposed to be included.

In addition to this the House Appropriations Committee has recommended another $3,500,000,000 appropriation for continuation of the construction of the 729 ships to compose the Two-Ocean Navy.

The Fourth Supplemental Defense Appropriation Bill, amounting to $1,533,000,000, was passed by the Senate on March 13. This bill makes deficiency and supplemental appropriations for the Army and Navy for national defense for the fiscal year ending June 30, 1941.

* * * *

Works Progress Administrator Howard O. Hunter reports that 213 new WPA projects for national defense received approval during February, bringing the total of WPA money allocated for this purpose during the fiscal year to $266,000,000. At the end of February 488,000 men, or about one-fourth of all those on WPA payrolls, were engaged on defense projects.

WPA is being increasingly used on the airport construction program, a majority on civil airports, many on Army and Navy air bases. Approximately one-half of the funds allotted to WPA during February was for airport construction.

Biographical and Professional Records to Be Brought Up to Date

As related in the March issue of Civil Engineering, the Headquarters office staff is engaged in the task of recording the dates on which each member of the Society last furnished biographical data. The canvass has now progressed to the point where the date and the member's name are being inserted on the record form, preparatory to mailing.

It is anticipated that the actual mailing of the record forms to the Society membership in the United States and possessions will take place during the month of April. Members who furnished similar data during or subsequent to 1940 will not be requested to submit a new record. Filling in the member's name, furnishing the date on which biographical material was last submitted, and eliminating data available from other sources should result, it is hoped, in a higher percentage of returns.

It is desired that every member of the Society fill out this record form and return it promptly.

Watch for your copy.

New Yearbook to Be Distributed with April Proceedings

The 1941 Society Yearbook, issued as Part 2 of Proceedings, will be mailed to the membership April 15, and will include in its alphabetical and geographical lists all changes reported by members up to February 3.

Because of the substantial increase in membership during the year, this issue will be considerably longer than the 1940 edition, and with the numerous changes in position and address resulting from the activity of civil engineers in the defense program, it should be especially useful for reference.

Student Guidance Work Successful

The Special Committee on Student Guidance of the Metropolitan Section, under the chairmanship of Arthur G. Hayden, reports that student guidance along engineering lines by the New York Engineers' Committee for Student Guidance (of which Mr. Hayden is also chairman), comprising representatives from the five national engineering societies, is an outstanding success, and is receiving the unqualified support of the high school staffs in New York City.

During the year 22 meetings were held in 20 high schools and 2,200 students have been informed of the work of practicing engineers and advised of the educational and personal qualifications necessary for success in the profession of engineering. Upwards of one hundred consultations between selected students and practicing engineers were arranged during the year.

Districts and Zones Unchanged

The Board of Direction, at its meeting on January 13, 1941, confirmed the boundaries of the Districts and Zones into which the membership of the Society has been divided, retaining the same division as that in force since January 1940. This statement is published in order to conform to the requirements of the Constitution, Article VII, Section 1—that the boundaries of both Districts and Zones shall be announced to the Corporate Membership not later than April 1 in each year.

Of General Interest

As in the past years, a public speaking course is again being undertaken by the Junior Branch of the Metropolitan Section. A regular instructor has been secured, and classes began on January 29, to be held weekly through May 15. This is a valuable idea that may be useful to corporate as well as Junior groups elsewhere.

Appointments of Society Representatives

Dudley T. Corning, Charles A. Howland, and Francis P. Witmer, Members Am. Soc. C.E., have been appointed the Society's delegates to the annual meeting of the American Academy of Political and Social Science, to be held at the Benjamin Franklin Hotel in Philadelphia, Pa., on April 4 and 5.

News of Local Sections

Scheduled Meetings

Cincinnati Section—Dinner meeting at the Student Union Building, University of Cincinnati, on April 8, at 6:30 p.m.

Cleveland Section—Luncheon meeting at the Guildhall on April 7, at 12:15 p.m.

Colorado Section—Dinner meeting at the University Club on April 14, at 6:30 p.m.

Dayton Section—Luncheon meeting at the Engineers' Club on April 21, at 12:15 p.m.

Illinois Section—Dinner meetings of the Junior Section at the Central Y.M.C.A. Cafeteria on April 14 and 28, at 5:45 p.m.

Indiana Section—Dinner meeting in the Board of Health Building, Indianapolis, on April 4, at 6:15 p.m.

Ithaca Section—Dinner meeting at the Arlington Hotel, Binghamton, N.Y., on April 18, at 6:30 p.m.

Los Angeles Section—Dinner meeting at the University Club on April 9, at 6:15 p.m.

Metropolitan Section—Technical meeting in the Engineering Societies Building on April 16, at 8 p.m.

Miami Section—Dinner meeting at the Alcazar on April 3, at 7 p.m.

Michigan Section—Joint dinner meeting with the Michigan State College Student Chapter at Lansing.

Nashville Section—Dinner meeting at Kissam Hall, Vanderbilt University, on April 8, at 6:30 p.m.

NORTH CAROLINA SECTION—Annual meeting at the King Cotton Hotel, Greensboro, N.C., on April 5, beginning 9:30 a.m.

NORTHEASTERN SECTION—Dinner meeting at the Engineers' Club on April 16, at 6 p.m.

NORTHWESTERN SECTION—Dinner meeting at the Minnesota Union on April 7, at 6:30 p.m.; dinner meeting of the Junior Chapter at the University of Minnesota on April 28, at 6:30 p.m.

PHILADELPHIA SECTION—Dinner meeting at the Engineers Club on April 8, at 6 p.m.

PITTSBURGH SECTION—Dinner meeting at the William Penn Hotel on April 17, at 6:30 p.m.; Junior Division will attend the North Central Conference of Student Chapters, to be held in Pittsburgh on April 17, 18, and 19.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers' Club on April 15, at 5:30 p.m.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on April 28, at 12:15 p.m.

SPOKANE SECTION—Luncheon meeting at the Davenport Hotel on April 10, at 12 m.

SYRACUSE SECTION—Dinner meeting at the Onondaga Hotel on April 2, at 6:30 p.m.

TACOMA SECTION—Dinner meeting at the Lakewood Community Center on April 8, at 6:30 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Chattanooga Sub-Section at the Y.W.C.A. on April 8, at 5:45 p.m.; dinner meeting of the Knoxville Sub-Section at the S & W Cafeteria on April 8, at 5:45 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on April 7, at 12:10 p.m.

TOLEDO SECTION—Dinner meeting at the Toledo Club on April 2, at 6:30 p.m.

UTAH SECTION—Field trip to K.S.L. Radio Station.

Recent Activities

CENTRAL ILLINOIS SECTION—*Springfield, January 28:* Joint dinner meeting with the local groups of the Illinois Society of Engineers, the Illinois Association of Highway Engineers, and the Springfield Engineers Club. The technical program consisted of the presentation of films, which were furnished by the U.S. Steel Corporation and the Massachusetts Institute of Technology.

CLEVELAND SECTION—*February 3 and March 3:* At the first of these sessions colored motion pictures of the Grand Rapids (Mich.) and Boston (Mass.) pressure aqueducts were shown by F. F. Longley, vice-president of the Lock Joint Pipe Company of Boston, Mass. Colonel Longley described the processes of manufacture, handling at the plant, transportation, and laying. The speaker at the March meeting was W. D. Hines, director of public relations for the Firestone Tire and Rubber Company, who discussed the Firestone Rubber Plantation in Liberia, West Africa. After describing the initial difficulty of landing men, equipment, and materials for construction purposes, he presented a film showing the development of a rubber plantation from start to finish.

COLORADO SECTION—*January 27 and February 10:* A special dinner meeting was held on January 27 in honor of Charles P. Berkey, Honorary Member of the Society, who gave an illustrated lecture on the "Engineering Geology of New York City." Dr. Berkey stated that there are thirty-five geologic formations between the Catskills and the sea. All of them contain many major and minor faults, he said, and most of the problems encountered in aqueduct and tunnel construction have been caused by the minor faults. At the February meeting Lt. Col. Harold M. Tague, of the U.S. Army Recruiting Service, showed a sound movie on the manufacture of Lockheed planes. The film provided a fitting introduction to the address of the evening, which was presented by Lt. Col. Early E. W. Duncan, commanding officer of Lowry Field and Fort Logan. Colonel Duncan spoke on the function of the army air corps in the present scheme of national defense and stressed the need of a "sound national policy."

GEORGIA SECTION—*Atlanta, February 10:* A symposium on traffic problems comprised the technical program. The principal talk was given by Frank H. Neely, chairman of the Fulton County Planning and Zoning Commission, who with the aid of maps and diagrams reviewed the traffic situation in Atlanta and Fulton County and described the master traffic control plan for the county now being prepared by the Commission. Dr. Adams and Troy Chastain, members of the Commission, commented on the plan and asked for the support of the profession in presenting the situation to the public, and R. L. MacDougall suggested that after the defense work is completed there will be a real need for meritorious public works projects. Raymond Torras then spoke briefly on the financial problems involved in long-range planning.

ILLINOIS SECTION—*Chicago, February 6:* Approximately 500 engineers—members of the Section and local groups of six other participating societies—gathered to honor Theodore T. McCrosky, recently appointed executive director of the Chicago Plan Commission. Following speeches of welcome by representatives of each of the participating groups, papers were presented by Philip Harrington and Ralph H. Burke, respectively commissioner and deputy commissioner of the Chicago Department of Subways and Superhighways. Mr. Harrington's paper was on "Mass Transportation Improvements for Chicago," while Mr. Burke treated the more specific problems of subway construction.

INDIANA SECTION—*Indianapolis, February 7:* A discussion on engineering education initiated the program, the speakers being R. B. Wiley, head of the civil engineering school at Purdue University, and H. S. Morse, vice-president and general manager of the Indianapolis Water Company. Professor Wiley cited what seemed to him certain defects in engineers' education and advocated a longer training period, with provision for more cultural and social subjects in addition to the present technical requirements. Three members of the Section's Committee on Civilian Protection in War Time then discussed the measures being taken to preserve public water supplies and sewage and refuse disposal systems. A movie on water, shown through the courtesy of the Indianapolis Water Company, concluded the meeting.

LOS ANGELES SECTION—*February 12:* A talk on the war was given by Bill Henry, columnist for the *Los Angeles Times*, who spoke from the vantage point of experience as a war correspondent in Europe. Melville Dozier, Jr., executive director of the Los Angeles County Housing Authority, then led a general discussion on "Making Public Housing Practical." A meeting of the Junior Forum, which preceded the regular meeting, was devoted to a discussion of the processes involved in making blueprints and other reproductions.

MARYLAND SECTION—*Baltimore, February 14:* An illustrated lecture on the Lake Washington Pontoon Bridge and the Tacoma Narrows Bridge was given by R. B. McMinn, senior highway engineer for the Public Roads Administration. A brief review of the history of pontoon and suspension bridges in general preceded a discussion of the more specific construction problems involved in the two bridges and of the structural and aerodynamic model tests made in connection with the Tacoma Bridge.

METROPOLITAN SECTION—*February 19:* The development of rapid transit in New York City from the initial stages in 1900 to the recently completed Sixth Avenue Subway, which rounded out a transit system upon which the city has expended approximately $1,900,000,000, was the subject of discussion at this meeting. The principal paper was presented by Charles E. Conover, consulting engineer and former division engineer for the Board of Transportation, who described some of the difficult and diverse problems encountered in the work. The paper was interestingly discussed by Louis E. Robbe, assistant division engineer for the Board of Transportation, who referred by name to the many members of the Society who have played an important part in the work.

NEW MEXICO SECTION—*Albuquerque, February 14:* Over 225 engineers from all over the state attended the sixth annual engineers' banquet, which was sponsored by the Section in conjunction with the Highway Conference at the University of New Mexico. The program consisted of a dinner, followed by a floor show and entertainment.

OKLAHOMA SECTION—*Oklahoma City, February 22:* A symposium on "Engineering and National Defense Preparedness" was led by Edward R. Stapley, professor of civil engineering at Okla-

homa Agricultural and Mechanical College. Local defense problems were discussed by G. R. McAlpine, chief of the Oklahoma City Fire Department, and M. B. Cunningham, superintendent of the Oklahoma City Water Department. Following a general discussion of the subject, a reel of motion pictures on "playful hippos" and the collapse of the Tacoma Bridge was shown.

PHILADELPHIA SECTION—*February 22:* The annual social meeting took place, with Lyle Jenne as master of ceremonies. Following a dinner and old-fashioned Community Sing, President Fowler and other Society officers spoke briefly. Then the group enjoyed a program of music, ballet dancing, and feats of magic, and later a film entitled "Safari on Wheels" was presented through the courtesy of the Standard Oil Company of Pennsylvania. This picture showed an 11,000-mile trip by truck across desert and jungle. Dancing concluded the evening.

PITTSBURGH SECTION—*February 19:* A symposium on engineering education was the feature of this joint meeting with the civil section of the Engineers' Society of Western Pennsylvania. The first speaker on the program was F. L. Bishop, secretary of the Society for the Promotion of Engineering Education, who outlined the problems confronting engineering schools and stressed the present emergency and the program to be adopted in meeting the demand for engineers. About 65,000 are enrolled in the engineering preparedness program in 150 institutions, Professor Bishop pointed out, and the average age of those enrolled is about 37. The other speakers were G. S. Richardson, member of the Pennsylvania State Board for the Registration of Professional Engineers, and A. J. Ackerman, director of engineering for the Dravo Corporation. The former discussed some of the reasons why engineers fail to secure their professional licenses, while Mr. Ackerman outlined a program of education for engineers that would include an "internship" of practical experience followed by a return to school. Mr. Ackerman also advocated a closer contact with high school students in order to discover suitable engineering talent.

ST. LOUIS SECTION—*February 24 and 27:* The speaker at the first of these sessions was George K. Miltenberger, general superintendent of electrical operation for the Union Electric Company, whose topic was "Behind the Scenes at Venice No. 2 Power Plant." The second meeting took the form of a joint session with the Engineers' Club of St. Louis. A lecture on "The Origin of Floods at the Ground Surface" was the feature of the occasion. This was given by W. W. Horner, consulting engineer and professor of municipal and sanitary engineering at Washington University, who illustrated his remarks with slides showing rainfall, infiltration, and runoff for various drainage areas and showed the possibilities of predicting runoff from a given area.

SAN FRANCISCO SECTION—*January 24 and February 18:* In January the Section participated in the annual joint meeting of the member societies of the San Francisco Engineering Council. Maj. Gen. David P. Barrows spoke on "American Defense Beyond the Western Hemisphere." An illustrated talk on construction work to date on the Shasta Dam was the feature of the regular bimonthly dinner meeting, which took place in February. This was given by Ralph Lowry, construction engineer for the U.S. Bureau of Reclamation in charge of the Kennett Division of the Central Valley Project.

TACOMA SECTION—*February 11:* The weak points of the Washington Engineers' Registration Act were discussed by J. W. Cunningham, Director of the Society, who also gave a résumé of the Annual Meeting. Stan Dragnich, a Reserve Officer, then spoke on "The Military Engineer and His Duties in Time of War." The meeting concluded with an illustrated lecture on the subject, "Some Fundamental Principles of the Occurrence and Withdrawals of Ground Water Supplies," given by Arthur W. Piper, senior geologist of the Water Resources Branch of the U.S. Geological Survey.

TENNESSEE VALLEY SECTION—*Chattanooga Sub-Section, February 11:* The planning needs of the city of Chattanooga were discussed by P. H. Wood, president of the Converse Bridge and Steel Company. Mr. Wood gave an interesting picture of the functions of the City Planning Commission and its relation to the city and regional plan in accordance with state laws. *Knoxville Sub-Section, February 11:* A talk on modern steam plant development, with specific reference to the design of the Watts Bar steam plant, was given by Marcus K. Bryan, consulting engineer for Charles T. Main, Inc. Mr. Bryan is in Knoxville as consultant to the TVA on the Watts Bar steam plant.

TOLEDO SECTION—*February 5:* The technical program consisted of a talk on "Propaganda in the News," which was presented by William Hall, associate editor of the *Toledo Blade*. The speaker reviewed the propaganda in effect during the World War and explained how careful reading and intelligent interpretation are necessary to get an even moderately accurate picture of current events.

VIRGINIA SECTION—*Richmond, February 14:* The annual meeting of the Section took the form of a business session in the morning and an afternoon technical program followed by a dinner meeting. Those appearing on the technical program were W. H. Lewis, of the Virginia Polytechnic Institute Student Chapter, who read a paper on "The W. K. Kellogg Foundation—Engineering for Public Health"; Frank G. Louthan, Jr., of the Virginia Military Institute Chapter, who discussed "The Manufacture of Modern Concrete Pipe"; and M. M. Sutherland, engineer and research technician for the Virginia State Planning Board, whose subject was "Engineering Phases of State Planning." The Tacoma Bridge film was then shown, and W. R. Glidden led a discussion of the reasons for the failure of the structure. A number of Society officers, including President Fowler, Vice-President Stevens, Director Requardt, and Secretary Seabury, attended the dinner meeting and spoke briefly on subjects of Society interest. A talk on "The Present Crisis" by Thomas Lomax Hunter concluded the meeting. During the business session the following officers were elected for the coming year: G. M. Bowers, president; E. S. Thomas, first vice-president; W. R. Glidden, second vice-president; and T. W. Roby, third vice-president. P. A. Rice continues as secretary-treasurer.

WISCONSIN SECTION—*Milwaukee, January 23 and February 13:* An illustrated lecture on the "Development of Suspension Bridges" preceded the showing of the Tacoma Bridge film at the first of these meetings. This was given by Charles S. Whitney, consulting engineer of Milwaukee. The feature of the February meeting was the showing of a colored motion picture, depicting the construction and operation of the air bases at Wake, Midway, and Guam Islands. The film was furnished by Pan-American Airways.

Student Chapter Notes

BROWN UNIVERSITY—*February 19:* The Chapter president, William F. Allen, discussed plans for the Student Chapter Conference to be held at Brown on April 25. Plans for increasing the scope of the Chapter's activities and for arousing the interest of freshmen and sophomores in the work of the Chapter were also considered.

COLLEGE OF THE CITY OF NEW YORK—*February 25:* An illustrated lecture on the theoretical and practical aspects of the design of buttress dams, with specific reference to the Possum Kingdom Dam in the Brazos River valley, was presented by a member of the Armbruster Engineering Corporation.

NEWARK COLLEGE OF ENGINEERING—*February 10 and March 3:* At the first of these meetings George G. Kelcey, sales manager of the Signal Service Corporation, discussed the channelization of traffic. By means of slides and sketches Mr. Kelcey showed how bottleneck intersections, which were formerly dangerous, have been improved. "Construction of a Concrete Deck-Girder Highway Bridge" was the subject of a talk at the March meeting. This was given by Peter Skurla, a senior at the Newark College of Engineering, who explained the various phases in the construction of a bridge he had worked on.

NEW YORK UNIVERSITY—*March 4:* The technical program consisted of the showing of a colored motion picture, entitled "The Romance of Steel," which had been loaned by the U.S. Steel Corporation.

UNIVERSITY OF TENNESSEE—*February 15:* Members of the Chapter are keeping abreast of construction developments on the Cherokee Dam project on the Holston River, the most recent TVA project in the vicinity. On February 15 they made their second trip and viewed the compression concrete tester in the laboratory as well as test-drilling in the field.

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for May

Conflicting requirements of reservoir operation for different purposes have sometimes roused proponents of the diverse interests involved to heated argument. In the May issue, however, Mr. Bowden describes the reconciliation of these difficulties effected by the Tennessee Valley Authority. Coordination of operations with use and inflow predictions is one of the important factors discussed. The subject is particularly timely in conjunction with the problems now before national planning agencies.

A notable bridge across the Passaic River in New Jersey is described by Henry C. Tammen and Ellis E. Paul. It has a lift span 332 ft long that rises 95 ft. Considerable improvement in appearance has been achieved by placing the hoist machinery in the towers instead of on the lift span. The towers were erected with the help of a stiff-leg derrick supported on a triangular construction frame. Special attention was given to the synchronizing and lubricating mechanisms.

In a paper describing the engineering philosophy underlying the wide variety of work performed by WPA, Perry A. Fellows points out the simple origin of many misunderstandings, and shows why the achievements of the organization should not be measured by the same standards applied to public works executed under the more usual directives. The paper is a convincing commentary on an epochal attempt to adjust human needs to a national work economy.

A portable tiltmeter for the control of grouting operations, a sand-shell base for a Texas highway, and some special applications of the column analogy are other subjects that may be treated in the May issue.

Prof. N. G. Neare's Column

Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

"Since this meeting of the Engineers Club falls on the first day of April," said the Professor with a grin, "I can say 'April Fool' to those who came to hear the answer to the March problem of the Titus Hitch. Hereafter, two months will intervene between propounding a problem and

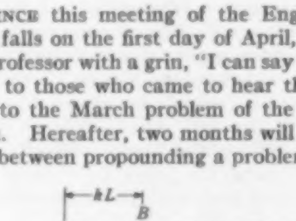


Fig. 1

offering a solution, in deference to those who have asked for more time. Not for more time to work the puzzle—but for more time to find time to start.

"Incidentally, belated solutions to the January problem of the *U.S.S. Swing* were unanimous in conflicting with one another and with my answer, until George Paaswell (not a *nom-de-quiz*) submitted a grade-A paper, agreeing with the answer published in February. Although George and I are still a minority, we can outvote any other solution; we hope we are right.

"I must acknowledge another reply to the February Balcony Beam Paradox. In a unique demonstration, Richard Jenney supports Professor Wise's statement that the shape of the beam for which a straight beam is a limit is itself indeterminate. Jenney drew the beam with two dog-legs, as in Fig. 1. Following Wise's notation and procedure:

$$Z_B = wL\left[2k + \sqrt{\frac{y^2}{L^2} + (1-k)^2}\right]$$

$$\text{As } y = 0,\ Z_B \doteq wL(1+k)$$

$$\text{Since } 0 < k < 1,\ wL < Z_B < 2wL$$

"My thanks also to J. W. Pickworth, who sent in a copy of a proposed bungalow plan developed by the Scotch architect Mac McMack for rapid reconstruction after air-raids. He was able to reduce the cost of each bungalow by 19 cents' worth of blueprinting, because one drawing serves for two views.

"Assuming the drawing to be complete and that no dotted lines have been omitted, as in Fig. 2, can any of you draw the side view?"

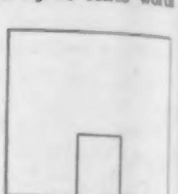


Fig. 2

(The Balcony Beam Paradox was submitted by Joseph A. Wise, Lt. Commdr., U.S.N., formerly a professor of civil engineering at the University of Minnesota. Acknowledgment was intended in the text by referring alternately to Commander Wise and to Professor Wise; in retrospect that seemed incomplete.)

Survey of Community Facilities Needed in Defense Areas

A group of engineering consultants especially experienced in city management is assisting the Division of State and Local Cooperation of the office of Production Management and the Advisory Commission to the Council of National Defense, in making an appraisal of necessary community facilities in defense areas. These consultants have been sent to various parts of the country where lack of community facilities for defense activities might impede the national defense program. Certain cities have loaned their city managers to the Division to undertake the survey.

"Defense areas" can be divided into two general categories—those in which there are defense industries and those adjacent to military concentrations.

The purposes of the survey include the determination of the need for defense-connected community facilities, the absence or lack of which will impede or is now impeding national defense; what resources the locality or the state has to meet these needs; and what if any federal funds appear necessary. Legislation has been introduced by a message from the President to the Congress requesting an appropriation of $150,000,000 for this purpose. Community facilities include water supply, sewage disposal, city streets, schools, recreation centers, and similar facilities.

An intensive survey was launched at a conference called by the Division of State and Local Cooperation in Washington on February 21 and is expected to be completed within 30 days. Frank Bane, Director of the Division of State and Local Cooperation, has selected the following city managers to assist in making this survey, and has assigned them to the states indicated opposite their names:

City Manager	States
R. W. B. Hart, M. Am. Soc. C.E., of Lynchburg, Va.	Alabama and Mississippi
Roy Braden of Greenbelt, Md.	Georgia and Florida
R. M. Cooksey, M. Am. Soc. C.E. of Thomasville, N.C.	Tennessee and Arkansas
I. C. Brower, M. Am. Soc. C.E., of Fort Lauderdale, Fla.	Va., N.C. and S.C.
Carl Smedberg, M. Am. Soc. C.E., of Greensboro, N.C.	Louisiana and Missouri
Bryan Miller of Wichita Falls, Tex.	Oklahoma, Iowa and Minnesota
H. I. Stites, M. Am. Soc. C.E., Burbank, Calif.	Texas
John Ames, M. Am. Soc. C.E., of Ames, Iowa	California
Don McMillan of Ventura, Calif.	Oregon and Washington
Edward S. Clark of Kalamazoo, Mich.	Wisconsin and Indiana
D. E. A. Cameron of Toledo, Ohio	Illinois
J. E. Barlow of Portland, Maine	Michigan
C. A. Harrell, M. Am. Soc. C.E., Schenectady, N.Y.	Rhode Island

The Origin of the Voussoir Arch

By Rudard A. Jones, Jun. Am. Soc. C.E.

Assistant Professor of Structural Design, Department of Architecture, Kansas State College, Manhattan, Kansas

This is an abstract of the winning paper in a Junior competition held by the Indiana Section. At the time of the award, Mr. Jones was a graduate student in architectural engineering at the University of Illinois.

It is interesting to examine the early history of the arch in the light of recent archeological explorations. In the past, various peoples have been given credit for its invention—first the Etruscans and more recently the Assyrians.

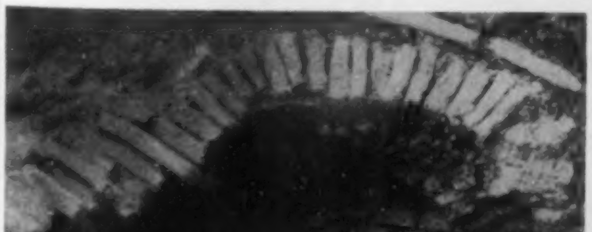
As one early historian has suggested, the arch was probably invented by a people that had available only small units of building material. From early times builders in regions where wood or large slabs of stone were not easily available have been forced to use ingenuity in spanning from wall to wall, even in the smallest buildings. Such a region is Mesopotamia, lying between the Tigris and Euphrates rivers, where excavations of late years have brought to light examples of very early arches.

The Tigris and Euphrates trace the greater part of their course through a low flat plain of alluvium which they have deposited in the course of several thousand years. The shore line of the Persian Gulf has moved southward because of these deposits approximately 350 miles since ancient times, but every part of this area, even in the past, was from 40 to 200 miles from a stone quarry, and the only locally available type of tree was the date palm and related species.

Before the present war the British Museum and the University of Pennsylvania sent individual and joint archeological expeditions into this territory, and their findings throw new light upon the antiquity of the arch. At an early date (approximately 3500 B.C.) there was already in lower Mesopotamia a flourishing civilization built up by a people who were thoroughly familiar with the use of the arch, who were the inventors of the cuneiform system of writing, and who were master goldsmiths. Just who these people were is a mystery. Some authorities maintain that the Sumerians were native to the area, but the majority of evidence indicates that they were immigrants and may have brought the arch with them.

The Sumerians, Babylonians, and Assyrians placed their buildings on a platform several yards high as a protection from floods. Both platforms and buildings were constructed of sun-dried bricks of various sizes and shapes, protected in some cases by a facing of burnt brick laid in asphalt mortar. This type of construction does not last too well over a period of thousands of years. All roof structures have long since disappeared, and it is with the greatest difficulty that any authentic idea of the original method of spanning from wall to wall can be obtained. C. L. Woolley, of the Joint Expedition, was greatly pleased, therefore, to discover the Royal Cemetery of Ur—a burial ground that had remained more or less untouched throughout the centuries. It is from his book, *Ur Excavations*, that the accompanying illustrations are taken. The graves were of various types—some with true arched roofs and others with corbeled, or false-arch, roofs. The latter were constructed of stone (imported of course), which was laid up in vertical walls to a height of approximately 4 ft, at which point the stones were corbeled inward toward the top, where the two walls were capped with a row of single flat stones.

Of more interest, however, are the true arches. These burial vaults are similar in size to the corbeled vaults—roughly 4 to 6 ft wide, 8 to 12 ft long, and 4 to 6 ft to the spring line of the vault. Various means of construction seemed to have been used. Mr. Woolley was puzzled by the position of some of the stones in the walls, which were so small and of such shape that it seemed impossible that they could stay in position when laid up in the mud mortar used. Careful excavation of one of the tombs, however, revealed form marks near the base of the wall, indicating that the walls were poured in the manner of concrete rubble. This would account for the lack of regular coursing as well as for the position of the smaller stones, which apparently stayed in the wall only because they were held in by the forms while the mud mortar dried. The excavators found the debris of wood beams which had fallen and, also, sockets in the side walls into which the beams had been set. Comparisons among the several tombs showed that the beams were used as support for a platform of mud and straw, which served as centering for the arch above. In some cases this centering was removed and the under side of the vault plastered with a coat of lime. In other vaults the centering was left as the finished ceiling.



From "Ur Excavations" by C. L. Woolley

A Tomb Chamber After Excavation
Vault and Apsidal End of Burnt Brick Rest on Walls of Limestone Rubble

In some, more care was taken with the coursing of the stone. A few of the vaults were roofed over one end with a half dome, as in an apse. In their transition from the square plan to the round plan of the half dome, the Sumerian builders used a rough spherical triangle in the corners of the room as support for the dome. Thus Woolley gives credit to these early builders for the invention of the pendentive, which is generally believed to have been developed in the Byzantine Age or shortly before.

The Sumerians also developed a method of constructing vaults without centering, a procedure used much later by the Assyrians in tunnel construction. Consecutive ribs of a barrel vault, instead of being made vertical and perpendicular to the axis of the arch, were raked back on a slope of approximately 60 deg to the horizontal. Thus each course of masonry could rest on the preceding course and centering was unnecessary. In one vault the half dome served as the support against which these sloping courses were started.

But the Sumerians went even further with their methods, as is attested by illustrations in Dr. Woolley's book showing two arches of flat bricks over doorways. Some critics have felt that the structures previously mentioned were not arches in their true form, but the authenticity of the two just referred to cannot be doubted. It is clear that the builders understood the wedging action of the voussoirs because bits of pottery were found wedged between the radial joints of the voussoirs to transfer the thrust of the arch so that the arch would not lose its shape before the mortar could harden.

The age of most of these structures is, of course, somewhat obscure; they are assigned to the period from 4,200 to 3,500 B.C. Considering their antiquity it is amazing how well they have been preserved.

It is generally known that the Assyrians of 700 B.C. and thereabouts used the arch in both barrel and pointed form for drains under the platforms of their mighty cities. Most authorities agree that the great long rooms of the palaces of Khorsabad were vaulted, and if we may believe illustrations left by the Assyrians, the common people lived in houses almost identical with those in which they live today—high, domically roofed structures built of sun-dried brick and plastered with mud.

In Egypt there are examples of brick arches that approach or equal the age of

the Sumerian work. However, present evidence indicates that the Egyptians did not use the arch nearly as much as their Mesopotamian neighbors, probably because they had an ample supply of large building stone for lintel-type structures.

If the arch was developed in Sumer, one hypothesis as to its origin seems very logical. There are today examples of

From "Ur Excavations" by C. L. Woolley

A BRICK ARCH STILL ROOFS THE TOMB CHAMBER OF AN ANCIENT QUEEN

mud huts built on a frame of reeds bent in the shape of an arch, and excavation has revealed similar structures at prehistoric levels. It follows that the Sumerians may have discovered, through the burning out of the reed supports or through some other accident, that the monolithic arch had no need of support once it had been baked in the sun of their dry land. Such huts may have been the forerunners of the graves of Ur where the rubble work was used. If this idea did not originate with the Sumerians, it is probable that they brought the arch with them when they immigrated to the valley, and that the spot where the arch was invented is yet to be found.

Whether or not the Sumerians did originate the use of the arch, we are indebted to them for some interesting examples of the ingenuity of early builders. The time has come when we must realize that the Assyrians, the Etruscans, and the Romans were following in the wake of early builders. And since it is now believed that the original home of the Etruscans was in Asia Minor, it is quite probable that any knowledge they had of arch construction was derived from the valley of the Tigris and Euphrates—that is, from the Sumerians.

Defense Training in the NYA Program

As a national defense measure Congress in October appropriated $7,500,000 to the U.S. Office of Education to provide vocational training facilities for 300,000 project workers in the National Youth Administration. Under the present arrangement, State Boards for Vocational Education and local schools will provide the instruction—with emphasis on such courses as blueprint reading, shop arithmetic, and basic training in the vocations most valuable to national defense activities. Local school authorities will assign teachers where necessary to provide such instruction, and in some cases will employ itinerant teachers to go from one project to another.

Labor Reserves Inadequate

PRELIMINARY tabulations of a sample of the Census enumeration taken last year, as reported by the Twentieth Century Fund, indicate that there were 5,110,000 persons completely unemployed and seeking work in the last week of March 1940. Adding 1,300,000 who had jobs but who were on temporary layoff and not actually at work, plus 2,905,919 employed on WPA and other emergency work programs, gives a total of 9,315,919.

This compares with an estimate made by the National Industrial Conference Board for the same period and placed at 9,269,000. Using the same methods which proved so accurate in March, the Conference Board set the number of full-time unemployed in November 1940 at 7,217,000. After deducting the estimated workers on government projects, those on temporary layoff, and those likely to be affected by the draft, it is probable that the number of idle workers in the labor market available for employment in the near future is probably not far from 4,000,000.

On the basis of 1940 appropriations it seemed reasonable to predict an increase in employment of around 6,000,000 between the fall of 1940 and the fall of 1942. Under the expanded program the increase will clearly be larger than this, and must certainly exceed the available labor supply.

Contemplated Revision of Drinking Water Standards

REQUIREMENTS for drinking (and culinary) water provided by common carriers for the use of passengers carried in interstate traffic, commonly known as the "Treasury Department Drinking Water Standards," were last revised in 1925 and were published in the Public Health Reports of April 10 of that year. Since then many improvements in water supply practice have been adopted with resulting increased uniformity in quality and safety to the consumer. The revision of the standards to conform more closely to current requirements for water supplies of attainable safety and potability is accordingly in order.

To carry out such a revision, the Surgeon General has appointed a special advisory committee composed of representatives of various federal organizations and scientific associations and several members at large. A smaller subcommittee of Public Health Service officers has been designated to prepare tentative suggestions for changes in the present standards which will be submitted for the consideration of the advisory committee.

The membership of the advisory committee is drawn from the American Chemical Society, American Public Health Association, American Society of Civil Engineers, American Water Works Association, Society of American Bacteriologists, Conference of State Sanitary Engineers, Food and Drug Administration, U.S. Geological Survey, and the Association of American Railroads, each of which has one representative. The chairman and secretary are from the Public Health Service and there are three members at large. Those serving on this committee or subcommittee who are members of the American Society of Civil Engineers are the following: Abel Wolman, Arthur E. Gorman, Charles R. Cox, Arthur D. Weston, R. F. Goudey, Herman G. Baity, and H. W. Streeter.

Civil Service Examinations Announced

MORE professional and sub-professional engineering examinations have been announced by the U.S. Civil Service Commission. The list of these includes an examination for superintendents of general construction for work in the national defense program. There are several grades of positions with salaries ranging from $3,200 to $5,600 a year, less a $3^1/_2$% retirement deduction. Broad and responsible experience is required, and qualified persons are urged to file their applications at the Washington office of the Commission before December 31, 1941.

Until further notice applications will also be received for an examination for construction inspection coordinator in the U.S. Maritime Commission. The salary is $3,800 a year, and applicants may qualify in three optional branches: hull, electrical, and machinery. The maximum age limit is 65.

Examinations for junior engineers at $2,000 a year (less $3^1/_2$% retirement deduction) are also open, and applications must be filed in Washington before December 31, 1941. Applications for positions as junior engineering draftsman at $1,440 a year must be filed not later than April 24, 1941.

Further details regarding these positions and application forms may be obtained at any first- or second-class post office, or from the Civil Service Commission, Washington, D.C.

Wheeler Project Report Published

THE Tennessee Valley Authority announces publication of its Technical Report No. 2, *The Wheeler Project*. The volume, which describes planning, design, and construction, contains 363 pages and 147 illustrations. It is the second of a series of TVA Technical Reports, the first of which was *The Norris Project* published in 1939.

History of the Tennessee River development forms the background for the report, which includes engineering, social, and economic studies; lock, dam, and powerhouse designs; access roads; employee housing; construction methods, with plant and river diversion procedures; reservoir adjustments, such as reservoir clearing and highway and railroad relocation; initial operations; a complete summary of the physical features of the project; copies of the engineering and geologic consultants' reports; résumés of special tests such as model studies; and a complete summary of construction costs. Comprehensive bibliographies are also given relative to each phase of the work.

Cloth-bound copies may be procured from the Superintendent of Documents, Washington, D.C., at $1.00 each.

Lamme Medal Awarded to Comfort Avery Adams

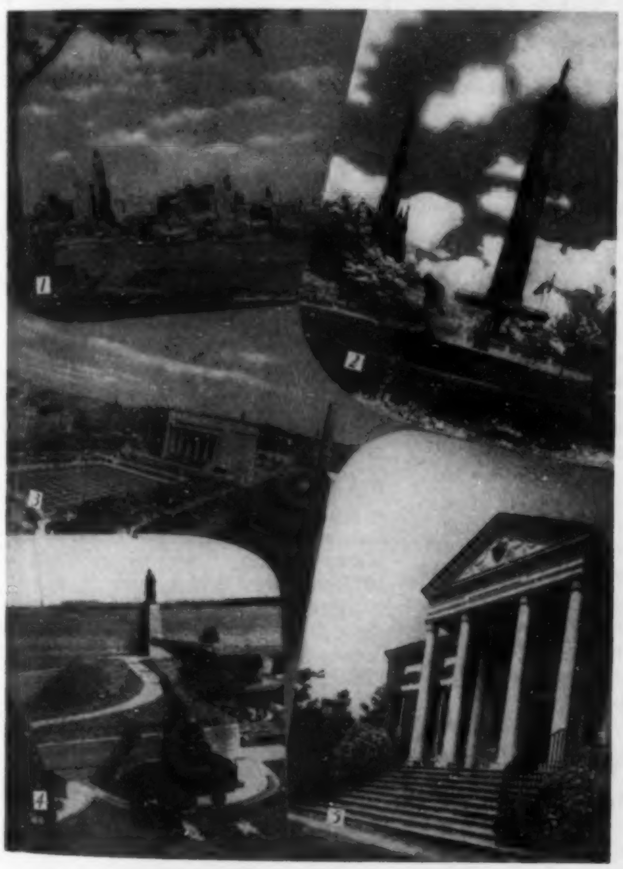
The 1940 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Comfort Avery Adams, M. Am. Soc. C.E., consulting engineer for the Edward G. Budd Manufacturing Company of Philadelphia, Pa. It is awarded "for his contributions to the theory and design of alternating current machinery and his work in the field of electric welding." The medal and certificate will be presented to him at the annual Summer Convention of the Institute, which is to be held in Toronto, June 16–20, 1941.

Mr. Adams graduated from the Case School of Applied Science in 1890 in Mechanical and Electrical Engineering, later receiving both the degree of Electrical Engineer and an honorary doctor's degree from the same institution. Associated with the noted physicist Dr. A. A. Michelson during his undergraduate work, he has retained his interest in scientific pursuits and has contributed many significant developments in electrical machinery design.

During the first World War Dr. Adams was chairman of the Welding Committee of the Emergency Fleet Corporation and chairman of the General Engineering Committee of the Council of National Defense.

Immediately after the war he organized and was first president of the American Welding Society (A.W.S.) of which he is now an honorary member and from which he received the first award of the Miller Medal "for conspicuous contributions to the welding art." From the beginning he has been in charge of the research activities of the A.W.S., first as director of the American Bureau of Welding and more recently as chairman of the Welding Research Committee of Engineering Foundation, sponsored by the A.I.E.E. and A.W.S. This committee is now steering cooperative research work involving an annual expenditure of well over $100,000 per year, most of which is contributed by the affected industries.

He is a past-president of the A.I.E.E. and of the A.W.S., has been prominent in the organizational activities of many other professional and scientific societies in this country, and is a member of the British, German, and French electrical engineering societies as well.



Baltimore Views on Front Cover of Civil Engineering

(1) Skyline of Downtown Baltimore and the Upper Harbor from Federal Hill Park; (2) Washington Monument and Mt. Vernon Place; (3) The War Memorial, City Hall Plaza, and Shot Tower; (4) Fort McHenry, Birthplace of the Star Spangled Banner; (5) The Homewood House or Carroll Mansion on the Campus of the Johns Hopkins University

Brief Notes

A bulletin describing tentative standards for "Reporting Results of Analysis of Industrial Waters" has recently been issued by the American Society for Testing Materials. The pamphlet contains recommendations on data to be included in the history of the sample and on the scope and accuracy of the analysis. It also suggests proper methods for describing hydrogen ion concentration, suspended solids, dissolved solids, and dissolved gases. Copies of the bulletin may be had for a nominal price at the headquarters of the A.S.T.M., 260 South Broad Street, Philadelphia, Pa.

* * * *

The *Concrete Manual*, published by the U.S. Bureau of Reclamation, has been revised and considerably amplified in a third edition recently made available. The manual deals at considerable length with concrete materials, their investigation and selection, the design of mixes, inspection, and laboratory tests, and the most advanced practice in manufacturing, placing, and curing. The Bureau's wide experience and years of scientific development work make the volume one of the most authoritative and up-to-date documents on the subject. It may be purchased at either the Washington or the Denver Office of the Bureau for $1.00.

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The Concrete Reinforcing Steel Institute is scheduled to meet at The Homestead, Hot Springs, Va., April 23–25.

NEWS OF ENGINEERS

Personal Items About Society Members

Members of the Society in the U.S. Naval Reserve who have recently been ordered to report for active duty are Lt. Comdr. Leslie J. Watson, from civil engineer and superintendent of lands for Alexander and Baldwin, Ltd., Honolulu, Hawaii, to active service with the Civil Engineer Corps, U.S. Navy, in connection with the construction of western Pacific air bases; and Lt. (jg) John A. Clark, from sanitary engineer in the San Francisco district office of the Farm Security Administration, U.S. Department of Agriculture, to active duty at the Mare Island (Calif.) Navy Yard. Of the Officers Reserve Corps of the Army there are Capt. James E. Travis, from head of the Relocations Section of the U.S. Engineer Office at Little Rock, Ark., to the 6th Engineer Battalion at Fort Riley, Kans.; and Lt. Stanley R. Biesack, C.A.C., from junior structural engineer for the Tennessee Valley Authority at Chattanooga, Tenn., to active duty at Camp Davis, Holly Ridge, N.C.

Walter L. Huber announces the association of Edward M. Knapik as a partner in his practice under the name of Walter L. Huber and Edward M. Knapik, consulting engineers, with offices at One Montgomery Street, San Francisco,

Calif. Mr. Knapik has been associated with Mr. Huber for over nineteen years.

CHARLES S. JOSLYN has been appointed area engineer of the Kingston–Wilkes-Barre (Pa.) Area Office of the Baltimore District of the U.S. Engineer Department. Previously Mr. Joslyn was in charge of the inspection and engineering divisions of the Kingston–Wilkes-Barre Area Office.

HOWARD P. MAXTON recently resigned as general cost engineer for the Tennessee Valley Authority to accept a position in the newly organized Progress Section of the Bureau of Yards and Docks, Washington, D.C., where he will be engaged in developing a statistical unit for construction cost control.

R. S. GUINN and J. NEILS THOMPSON, of the Texas State Highway Department, have been granted leaves of absence to serve as instructors for the special engineering defense training courses at the University of Texas.

WALTER E. KROENING has been made village manager of Greendale, Wis. He was formerly director of service and village engineer.

STEPHEN A. DEMING has resigned as city engineer of Columbia, Mo., in order to accept a position as assistant engineer in the structural department of the Panama Canal Zone.

FREDERICK E. HERTEL was recently promoted from the position of structural engineer for the Stone and Webster Engineering Corporation, Boston, Mass., to that of assistant chief structural engineer.

F. T. MATTHIAS has severed his connection with the Al Johnson Construction Company on dredging operations at Pickwick Landing Dam in order to join the staff of the Dravo Corporation, Pittsburgh, Pa. Mr. Matthias will work on the design of the concrete plant for Dravo's work on the Delaware Aqueduct.

HARRY M. HOUSE is now chief engineer for the Benham Engineering Company, of Oklahoma City, Okla., for whom he will serve as manager of construction work on an army cantonment at Alexandria, La.

MAX H. DOYNE, previously chief engineer and manager for C. E. Smith and Company, of St. Louis, Mo., has accepted a position as consulting engineer for the National Park Service on the Jefferson National Expansion Memorial Project at St. Louis.

BEN MOREELL has been promoted from the rank of commander, C.E.C., U.S. Navy, to that of captain. As chief of the Bureau of Yards and Docks, Washington, D.C., he also has the temporary rank of rear admiral. Other members of the Society recently promoted from the rank of commander to that of captain are CARL A. TREXEL, who is at the Bureau of Yards and Docks, Des Moines, Iowa; ALDEN K. FOGG, at the U.S. Navy Yard, Norfolk, Va.; EDWARD C. SEIBERT, officer in charge of construction of the Naval Air Station at Alameda, Calif.; WILLIAM HENRY SMITH, public works officer, Brooklyn Navy Yard; JOHN J. MANNING, at the Bureau of Yards and Docks, Troy, N.Y.; and LEWIS B. COMBS, at the Bureau of Yards and Docks, Rensselaer, N.Y.

HOWARD W. HOLMES was recently appointed state highway engineer of Montana.

HERBERT H. BROWN, formerly engineer in charge of the design and construction of the Milwaukee (Wis.) water purification plant, has been named superintendent of the city water works.

C. H. HOWELL has been promoted from the position of senior construction engineer for the U.S. Bureau of Reclamation on the Colorado–Big Thompson Project to that of acting supervising engineer. He will be in charge of operations pending appointment of a successor to PORTER J. PRESTON, who retired in January.

J. F. BYXBEE has resigned as city engineer of Palo Alto, Calif., after thirty-five years in this capacity, and has been retired to the position of consulting engineer. L. HAROLD ANDERSON, director of public utilities and deputy city engineer, has been appointed to succeed Mr. Byxbee.

EDWARD R. WINKLER, JR., until lately superintendent of construction at Camp Holabird, Baltimore, Md., has been appointed associate civil engineer in the U.S. Engineer Office at Norfolk, Va.

GERALD M. KEITH, consulting engineer of Jacksonville, Fla., has been appointed to carry on engineering experimental work at the University of Florida. He will also assist with the defense courses now being given in Jacksonville, Tampa, and Miami.

JAMES WILMOT is now project engineer for the Caribbean Architect-Engineer in the U.S. Engineer Office at St. Johns, Antigua, B.W.I. He was recently transferred from similar work at Port of Spain, Trinidad.

GEORGE V. T. BURGESS, former commercial relations manager of Electrical Research Products, Inc., New York, N.Y., has become a member of the staff of Coverdale and Colpitts, consulting engineers of New York.

JOHN M. NAGLE, of Houston, Tex., was recently appointed flood control engineer of Harris County (Texas) on the $32,000,000 program for that county.

JULIAN MONTGOMERY, who resigned last summer as state highway engineer of Texas because of ill health, has now recovered and opened a consulting office in the Littlefield Building in Austin.

EDWARD N. NOYES has moved from Dallas, Tex., to San Antonio, where he is in the office of the Zone Constructing Quartermaster of the 8th Construction Zone.

JOHN CRANE MCVEA, formerly municipal improvements engineer for Houston, Tex., is now director of the Houston Water Department.

FLOYD W. HOUGH recently completed his geodetic work for the Colombia Petroleum Company in Colombia and returned to the United States to accept an appointment as geodetic engineer with the U.S. Coast and Geodetic Survey in Washington, D.C.

DECEASED

CARL ASHLEY (M. '28) who was on the engineering staff of Joel D. Justin, of Philadelphia, Pa., died recently at the age of 62. From 1905 to 1914 Mr. Ashley was in charge of the design and construction of the New York State Barge Canal, and later (1924 to 1934) was chief engineer for the American Construction Company, of Cleveland, Ohio. From the latter year to 1938 he was vice-president of the Cleveland firm of James H. Schall and Company. During the war he served as a captain and major with the A.E.F. in France.

GEORGE HOLLAND BINKLEY (M. '02) for a number of years on the staff of the Market Street Railway, San Francisco, Calif., died on February 1, 1941. Before going to San Francisco Mr. Binkley was in engineering work in Chicago—successively, with the Pennsylvania Railroad, the Columbian Exposition, and the Calumet Electric Street Railway. During the war he served with the U.S. Shipping Board Emergency Fleet Corporation.

> *The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."*

JOHN SOULE BUTLER (Jun. '36) of Hampton, Va., died recently. Mr. Butler, who was about 26, graduated from Iowa State College in 1936. He then became connected with the Chicago, Milwaukee and St. Paul Railroad at Savanna, Ill., and later was assistant to the building inspector for the City and County of Denver (Colo.).

LOUIS LAY CALVERT (M. '21) of Boonton, N.J., died after a long illness in the Veterans Hospital at Coatesville, Pa., on February 7, 1941. He was 69. Mr. Calvert was chief engineer of the Tide Water Building Company from 1904 to 1917 and from 1920 to 1925. From 1917 to 1920 he served as lieutenant colonel in the Construction Division of the Quartermaster Department. Later he was with the United Gas Improvement Contracting Company and United Engineers and Constructors, of Philadelphia.

ALFRED JOHN CLEARY (M. '19) consulting engineer and, since 1932, city administrator of San Francisco, Calif., died on February 16, 1941. He was 56. From 1921 to 1930 Mr. Cleary was consulting engineer for the state of California on the development of various major engineering enterprises. Earlier in his career (1908 to 1915) he was assistant city engineer of San Francisco, and from 1916 to 1921 was chief assistant city engineer in charge of the Hetch Hetchy Project.

WILLIAM TURLEY COBURN (M. '41) for the past ten years utility officer for the U.S. Veterans Administration at Danville,

Ill., died on January 24, 1941, at the age of 55. From 1907 to 1913 Mr. Coburn was in the office of the Engineer of Bridges, Washington, D.C.; from 1915 to 1922 (except for a brief period in war service), with several foundation companies in New York; from 1922 to 1925, with the Bureau of Internal Revenue, Washington; and from the latter year until 1931, manager of the Detroit office of Parsons, Klapp, Brinckerhoff, and Douglas.

Warren Glenn Fowler (Assoc. M. '27) bridge engineer for Jackson County, Missouri, died in Kansas City on February 13, 1941, at the age of 45. From 1923 to 1926 Mr. Fowler was bridge designer and chief draftsman for the Missouri State Highway Commission; from 1926 to 1927, bridge engineer for the St. Joseph (Mo.) Board of Park Commissioners; and from the latter year to 1940, engineer for Black and Veatch, of Kansas City.

Howard Clifton Griswold (M. '15) for many years president of John P. Morton and Company, of Louisville, Ky., died on January 29, 1941, at the age of 73. Earlier in his career Mr. Griswold was assistant inspecting engineer for the Illinois Steel Company.

Claude Clement Hockley (Assoc. M. '12) consulting engineer of Portland, Ore., and former regional director for the PWA, died on March 4, 1941. Mr. Hockley, who was 62, at one time held executive posts with Canadian power companies and, for fifteen years, was with the Union Bag and Paper Company, of New York, and the Thilmany Pulp and Paper Company, of Kaukauna, Wis. He went to Portland in 1925 as a paper and pulp expert.

Herbert Frank Howe (M. '16) South American representative for the Barber Asphalt Company of New Jersey, died at Port-of-Spain, Trinidad, on February 16, 1941. Mr. Howe had spent most of his career in foreign service—he had been chief engineer of the Quito and Guayaquil Railroad in Ecuador and had also done railroad engineering work in Mexico, Cuba, China, and the Philippines. He had explored the upper Amazon and was made a Fellow of the Royal Geographic Society of London in recognition of his explorations in inner Tibet. During the war he served as a captain in the Corps of Engineers.

Murray Lee Hutton (M. '23) state conservation director of Iowa since 1935, died on February 18, 1940, as the result of injuries received in an automobile accident. He was 55. Mr. Hutton had been county engineer of several counties in Iowa and for ten years was assistant engineer of the Iowa State Highway Commission. Later (1929 to 1935) he was chief engineer of the Iowa State Board of Conservation.

James Henry Lynch, Jr., (Assoc. M. '29) division engineer for the City of Toledo, Ohio, was killed in an automobile accident on February 11, 1941. Mr. Lynch, who was 44, was in charge of the construction of the intake and conduit for the Lake Erie Water Supply Project, and was named a city division engineer in 1939. He first went to Toledo as an employee of the consulting firm of Greeley and Hansen, and earlier had been with the North Jersey District Water Supply Commission.

Charles Harry Moore (M. '01) who retired several years ago as chief engineer for the Erie Railroad, died in New York City on January 31, 1941. Mr. Moore, who was 77, had also been with the Chicago and Erie Railroad and the New York, Susquehanna and Western. Earlier in his career he was engaged in railway survey work in South America for the Ecuadorian Congress.

John Joseph Phelan (M. '20) utility officer for the Veterans' Administration Hospital at Wichita, Kans., died there suddenly on February 11, 1941. He was 61. Colonel Phelan was with the Coast and Geodetic Survey, the U.S. Geological Survey, and the United States and Canada Boundary Commission before serving in the World War. Later he was inspecting engineer in the Procurement Division of the Treasury Department and, for a number of years, had been with the Veterans' Administration in varying capacities. Active in military affairs, he was in command of the 376th Engineers, Reserve Corps.

Silas Bent Russell (M. '87) of St. Louis, Mo., died on January 15, 1940, at the age of 80, though the Society has just heard of his death. Mr. Russell was an engineer in the St. Louis Water Department for 35 years. Upon his retirement from this position in 1928 he established a consulting practice, which he maintained until his health began to fail a few years ago. Mr. Russell designed water-pipe systems for several cities and was one of the founders of the St. Louis Engineers' Club.

Earl Milton Spencer (Assoc. M. '22) general contractor of Topeka, Kans., died in Clarksburg, W.Va., on January 7, 1941, en route from Washington to Topeka. He was 51. In 1911 Mr. Spencer became a member of the contracting firm of F. M. Spencer and Son, which he owned at the time of his death. The firm was responsible for many building construction projects in Kansas.

Robert Neel Van Winkle (Assoc. M. '17) engineer and contractor of Delaware, Ohio, died on January 17, 1941, at the age of 56. From 1908 to 1917 Mr. Van Winkle was engineer in charge of building and opening stone-crushing plants at Greencastle, Ind., and Buffalo, N.Y. Later he was engaged in similar work for several companies, and from 1926 to 1935 he was general manager of the American Crushed Rock Company, of Delaware, Ohio.

Joseph White Williams (M. '30) since 1921 chief engineer for the Western Pacific Railroad Company, San Francisco, Calif., died on February 3, 1941. He was 61. From 1907 to 1917 and from 1919 to 1921 Mr. Williams was with the Northwestern Pacific Railroad Company. During the war he served as major and lieutenant colonel with the 18th Engineers, in charge of dock, hospital, camp, railroad yard, and storage depot construction in France.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From February 10 to March 10, 1941, Inclusive

Additions to Membership

Able, Thomas Andrew, Jr. (Jun. '40), Office Engr., Fiske-Carter Const. Co., Pisgah Forest, N.C.

Akin, Philmore Donald (Jun. '40), Chf. of Field Parties, State Assessment Survey, Box 315, Taos, N.Mex.

Aleck, Benjamin Jacob (Jun. '41), Junior Structural Engr., War Dept., U.S. Engr. Office, Box 1234 (Res., 731 North Crescent Ave.), Cincinnati, Ohio.

Babcock, Willard Farrington (Jun. '41), Instr., Civ. Eng. Dept., North Carolina State College, Raleigh, N.C.

Bass, William Lankford (Jun. '40), Contr., 8536 Sixteenth, N.W., Seattle, Wash.

Blackburn, Leland Vance (Jun. '40), Junior Engr., Pacific Elec. Ry., 6th and Main Sts., Los Angeles (Res., 1237 Verdugo Rd., La Canada), Calif.

Bourquard, Everett Homer (Jun. '41), Asst. Engr. (Civ.), War Dept., U.S. Engrs., Post Office Bldg., Baltimore, Md.

Brasic, Frank (Jun. '40), Junior Highway Engr., Dist. 6, State Div. of Highways, 126 East Ash St., Springfield (Res., 2225 Barry Ave., Chicago), Ill.

Bredvold, Lloyd Milo (Jun. '41), Senior Rodman, Eng. Dept., G. N. Ry., Broadway & Tower, Superior, Wis.

Brinckman, Albert Leach (Assoc. M. '41), Chf. Building Insp., City Hall (Res., 2324 Valley St.), Berkeley, Calif.

Buirgy, Theodore Francis (Jun. '40), Structural Draftsman, Am. Bridge Co., Gary Plant (Res., 4360 Washington), Gary, Ind.

Carigan, William Everett (Assoc. M. '41), State Insp., State Highway Dept., Frankfort Hotel, Frankfort, Ky.

Carter, Edward John (Jun. '41), Senior Eng. Aid, State Div. of Highways, 2001 Van Ness Ave., San Francisco (Res., 825 Mission Ave., San Rafael), Calif.

Chilcote, William Leonard (Assoc. M. '41), Associate Civ. Engr., Bureau of Highways, Dept. of Public Works, 314 Municipal Bldg. (Res., 4130 Falls Rd.), Baltimore, Md.

Clark, Leo Henry (M. '41), Structural Engr., W. E. Wood Constr. Co., 4649 Humboldt (Res., 19200 St. Marys Ave.), Detroit, Mich.

Collins, Charles William, Jr. (Jun. '40), Timekeeper and Clerk of Works, Peter Sartorio Const. Co., 681 Market St., San Francisco (Res., 785 Kingston Ave., Oakland), Calif.

Conlin, Daniel Joseph (Jun. '40), Civ. Engr., George A. Fuller Co. and Merritt Chapman & Scott Corp., Quonset Point, R.I.

Conklin, Robert Holt (Jun. '40), Sales Engr., Ludowici-Celadon Co., 161 Spring St. Bldg., Room 220 (Res., 4 East Wesley Ave., Apt. 1), Atlanta, Ga.

Cox, Alfred Thomas (Jun. '40), 217 East 82d St., New York, N.Y.

Cunney, Edward George (Jun. '41), 2233 Observatory Pl., N.W., Washington, D.C.

Dading, Charles Henry (M. '41), Constr. Engr., Public Buildings Administration, Federal Works Agency, U.S. Post Office, Canastota, N.Y.

Dean, George Thomas (Assoc. M. '41), 1725 Poyntz Ave., Manhattan, Kans.

Dees, Richard Carl (Jun. '41), 110 Ruff St., Paris, Tenn.

Dhamani, Pessumal Narumal (Assoc. M. '40), Asst. Engr., Public Works Dept., Khairpur State, Khairpur Mir's, Sind, India.

Dike, George Alexander (Jun. '40), Designer and Draftsman, Columbia Marine Shipyards (Res., 515 Kennewick), Kennewick, Wash.

Duszynski, Edwin James (Jun. '41), Asst. Supervisor of Constr., Dept. of Public Works, WPA, 844 North Market St. (Res., 1426 West Dakota St.), Milwaukee, Wis.

Eliassen, Rolf (Assoc. M.'41), Associate Prof., San. Eng., New York Univ., University Heights, New York, N.Y.

Eljashev, Alexander (Jun. '41), Civ. Engr., 92-16 Whitney Ave., Elmhurst, N.Y.

Evans, Roger Virgil (Jun. '41), Albion, Nebr.

Faller, Vincent Augustus (Jun. '41), Junior Engr., J. E. Greiner Co., 1201 St. Paul (Res., Knights of Columbus Club), Baltimore, Md.

Farrar, Roger Macy (Jun. '41), Civ. Engr., Standard Oil Co. of Venezuela, Apartado 35, Barcelona, Venezuela.

Fletcher, Arthur Whitney, Jr. (Jun. '40), Instrumentman, Whitman, Requardt & Smith, 2304 Lyndhurst Ave., Baltimore, Md.

Franke, Harold Hugo (Jun. '41), Junior Engr. (Structural), War Dept., Office, Quartermaster General, Constr. Div., Design Section, Warehouse, Fort Myer, Va. (Res., 5323 Twenty-eighth St., N.W., Washington, D.C.)

Fuller, Alfred Smith (Jun. '41), Draftsman, Tips Engine Works, 300 Baylor (Res., 317 East 10th St.), Austin, Tex.

Gardner, Frank Henry (Assoc. M. '41), Staff Engr., Federal Works Agency, 339 First National Bank Bldg., Montgomery, Ala.

Genter, Albert Legrand (M. '41), Cons. Engr., Wyman Park Apartments, Baltimore, Md.

Goldberg, Irvin Jay (Jun. '41), Designer, Reinforced Concrete and Timber, Benham Eng. Co., Camp Polk, Leesville, La.

Gossard, Myron Lee (Jun. '41), Instr., Civ. Eng., Univ. of Louisville, Louisville, Ky.

Grant, Burton Smith (Assoc. M. '41), Engr., Los Angeles Aqueduct, Bureau of Water Works & Supply, Box 3669 Terminal Annex, Los Angeles, Calif.

Gray, George Luther (Assoc. M. '41), Designer, Fabricated Steel Constr., Bethlehem Steel Co., Bethlehem, Pa.

Groves, George Robert, Jr. (Jun. '41), Estimating and Designing Engr., Reliance Clay Products Co., 2139 North Field St., Dallas, Tex.

Hall, Charles Eugene (Jun. '40), Junior Insp., Ordnance Material, St. Louis Ordnance Dist., War Dept., 935 U.S. Courthouse and Customhouse, St. Louis (Res., 419 North Penn St., Webb City), Mo.

Hanna, George Parker, Jr. (Jun. '40), Box 29, University Heights, New York, N.Y.

Higgins, Nathan Bert (M. '41), Chf. Engr., Pennsylvania Water & Power Co., 1609 Lexington Bldg., Baltimore, Md.

Hotler, Clarence Floyd (Jun. '40), With Quartermaster Corps, U.S. Army, Army Medical Center (Res., 1831 Monroe St., N.W.), Washington, D.C.

Hunter, Paul Artman (Jun. '40), 43 North Broad St., Nazareth, Pa.

Hutchison, Russell James (Jun. '40), 1st Lt., U.S. Army, 200 Coast Artillery, Fort Bliss, Tex.

Jackson, Bert Baker (Assoc. M. '41), Const. Mgr., Kuhne-Simmons Constr. Assn., Rantoul, Ill.

Jones, Edwin Yowell (Assoc. M. '41), Div. Engr., Cia Agricola de Guatemala, Tiquisate, Guatemala.

Knapp, William Harrison (Jun. '41), Field Engr., United Engrs. & Constrs., Inc., 1401 Arch St. (Res., 5516 Westford Rd., Olney), Philadelphia, Pa.

Lewis, Douglas Duane (Assoc. M.'41), Associate Engr., U.S. Geological Survey, Box 503, Knoxville, Tenn.

Li, Eu-Dien (Jun. '40), Prof., Structural Eng., National Univ. of Amoy, Changting, Fukien, China.

Linderman, Irving Edward (Jun. '40), Junior San. Engr., State Board of Health, 1098 West Michigan, Indianapolis, Ind.

Logli, Albert Joseph (Jun. '40), Asst. to Plant Engr., Greenlee Brothers & Co., 2136 Twelfth St. (Res., 110 South Johnston Ave.), Rockford, Ill.

Lucas, Leonard Edmond (Jun. '40), Archt. and Engr., Kingsbury Ordnance Plant, R.R. 2, North Judson, Ind.

Mabry, Henry Clyde (Jun. '41), Project Engr., WPA, Box 224, Decatur, Ala.

Mihalyi, Ernest Joseph (Jun. '40), Designer, H. H. Robertson Co., Fourteenth St., Ambridge (Res., 1700 Ridge Ave., Coraopolis), Pa.

Mokelke, Eugene Albert (Jun. '40), Asst. to Superv. Engr., Marquette Univ., 1210 West Michigan St. (Res., 1568 South 3d St.), Milwaukee, Wis.

Reading, Thomas James (Jun. '41), With Portland Cement Assn.; Mass. Inst. Tech., Room 1033, Cambridge (Res., 6 Newland Rd., Arlington Heights), Mass.

Sanford, John Graeme (Assoc. M.'41), Dist. Office Engr., State Highway Comm., Box 340, Vincennes, Ind.

Slater, James Price (Assoc. M. '41), Asst. San. Engr., FSA, Court House Bldg., 6th Floor, Milwaukee, Wis.

Sparks, Benjamin Franklin (M. '41), Upper Peninsula Engr., State Highway Dept., 701 Ludington St., Escanaba, Mich.

Steele, Joseph Middleton, 2d (Jun. '41), Structural Draftsman, United Engrs. & Constrs. Inc., Broad and Arch Sts. (Res., East Bells Mill Rd., Chestnut Hill), Philadelphia, Pa.

Steketee, Richard Henry (M. '41), Maintenance Engr., Board of Wayne County Road Commrs., 3800 Barlum Tower, Detroit, Mich.

Sullivan, Henry Joseph (M. '41), Asst. to Director, Eng. Div., PWA, North Interior Bldg. (Res., 1215 Sixteenth St.), Washington, D.C.

Tate, Manford Ben (Jun. '40), 201 South Sixth St., Columbia, Mo.

Taxer, Milton (Jun. '41), Junior Engr., U.S. Engr. Office, 628 Pittock Block, Portland, Ore.

Thomas, Ivor Rees (Jun. '40), With Henry J. Kaiser Co., Pleasanton (Res., 20937 Western Blvd., Hayward), Calif.

Thompson, Kenneth (Assoc. M.' 41), Engr., Design and Constr., City of Miami Beach, City Hall, Miami Beach, Fla.

Valdes, Agustin Manuel (Assoc. M. '41), Civ. Engr., Chf. Eng. Commr., Secretaria de Comunicaciones, Tacuba 8 (Res., Saltillo 28), Mexico, D.F., Mexico.

Vogel, Hans Wilhelm (Jun. '40), 121 B Roberts Hall, Univ. of Texas, Austin, Tex.

TOTAL MEMBERSHIP AS OF MARCH 10, 1941	
Members	5,676
Associate Members	6,571
Corporate Members	12,247
Honorary Members	35
Juniors	4,554
Affiliates	69
Fellows	1
Total	16,906

Wahl, Carl Merrill (M. '41), Asst. Engr., State Div. of Highways, Centennial Bldg. (Res., 1819 South 5th St.), Springfield, Ill.

Walter, Earl Ferdinand (Assoc. M. '40), City Engr., 817 Franklin St. (Res., 1006 North 15th St.), Manitowoc, Wis.

Way, Nathan Emeran (Assoc. M. '40), Associate Structural Engr., TVA, 313 Union Bldg., Knoxville, Tenn.

Williams, John Horter (Jun. '40), Asst. Engr., Southeastern Pipeline Co., 714 Forsyth Bldg., Atlanta, Ga.

Wray, William Jackson (Assoc. M. '41), Res. Engr. Insp., PWA, Box 476, Manning, S.C.

Membership Transfers

Ballard, James Irving (Jun. '25; Assoc. M. '29; M. '41), Managing Editor, *Engineering News-Record*, 330 West 42d St., New York (Res., 17 Trenton Ave., White Plains), N.Y.

Barnes, Stephenson Barton (Assoc. M. '28; M. '41), Cons. Structural Engr., 809 West 3d St., Los Angeles (Res., 2 Toluca Estates, North Hollywood), Calif.

Clarridge, Charles Evans (Jun. '36; Assoc. M. '41), Instr., Civ. Eng. Dept., Clarkson College of Technology, Main St., Potsdam, N.Y.

Cresswell, Frederick Sorensen (Jun. '32; Assoc. M. '41), Engr., Clay Sewer Pipe Assn., Inc., 205 West Glendale Ave., Alexandria, Va.

Cropper, George Bertrand (Jun. '33; Assoc. M. '41), Cons. Civ. Engr., 300 Baltimore Ave., Ocean City, Md.

Franzen, Edwin Chalmer (Jun. '31; Assoc. M. '41), Associate Engr., Corps of Engrs., U.S. Army, War Dept., Wright Bldg. (Res., 2920 East 1st St.), Tulsa, Okla.

Gevecker, Vernon Arthur Charles (Jun. '31; Assoc. M. '41), Asst. Prof., Civ. Engr., Missouri School of Mines, Rolla, Mo.

Hand, George Washington (Assoc. M.'15; M. '41), Asst. to Chf. Executive Officer, C. & N. W. Ry., 400 West Madison St., Room 1400, Chicago (Res., 412 Courtland Ave., Park Ridge), Ill.

Harker, Joseph Clyde (Jun. '32; Assoc. M. '41), Junior Engr., U.S. Bureau of Reclamation, Redding, Calif.

Hiegl, George, Jr. (Jun. '33; Assoc. M. '41), Constr. Supt., Kolyn Constr. Co., 207 Commonwealth Bldg., Trenton, N.J. (Res., 216 East Eleanor St., Philadelphia, Pa.)

Holland, Paul Leach (Assoc. M. '30; M. '41), Chf. Engr., Public Service Comm. of Maryland, 1701 Munsey Bldg., Baltimore, Md.

Horwath, Theodore Joseph (Jun. '32; Assoc. M. '41), Constr. Engr., M. W. Kellogg Co., New York, N.Y. (Res., 920 Bergen St., Newark, N.J.)

Howe, Homer Asa (Assoc. M. '28; M. '41), Cons. Engr., 201 Opera House Bldg. (Res., 2620 North 9th St.), Terre Haute, Ind.

Huebner, Carl Herman (Jun. '32; Assoc. M. '41), Asst. Supervisor of Real Estate, Met. Life Ins. Co., 1 Madison Ave., New York, N.Y. (Res., 109 North 6th St., Newark, N.J.)

Irwin, Raymond Lewis (Jun. '32; Assoc. M. '41), Associate Engr. (Hydraulic), Ohio River Div., U.S. Engr. Office, 1437 Enquirer Bldg., Cincinnati, Ohio.

Johnson, Cecil William (Jun. '33; Assoc. M. 40), 1705 East Howell St., Seattle, Wash.

Kabrich, Charles Edward (Jun. '32; Assoc. M. '41), Capt. (Engr.-Reserve), U.S. Army, 418 East Court St., Rockymount, Va.

Kettle, Kenath Austin (Jun. '33; Assoc. M. '37; M. '41), Chf. Draftsman, Carbide & Carbon Chemical Corp., 437 McCorkle Ave., South Charleston (Res., 3716 Staunton Ave., Kanawha City, Charleston), W.Va.

King, William Cecil (Jun. '36; Assoc. M. '41), Asst. Hydr. Engr., U.S. Dept. of Agriculture, 218 Old Pioneer Post Office Bldg., Portland, Ore.

Larkin, Kenneth Hoyt (Jun. '33; Assoc. M. '41), Structural Engr., Burns & McDonnell Eng. Co., 107 West Linwood Blvd. (Res., 2610 Lawndale St.), Kansas City, Mo.

Letherbury, John Boyd (Jun. '30; Assoc. M. '41), Hull Structural Designer and Specialist, New York Shipbuilding Corp., Camden, N.J. (Res., 7028 Woolston Rd., West Oak Lane, Philadelphia, Pa.)

MacMillan, William Wilson (Jun. '37; Assoc. M. '41), Senior Insp., Met. Water Dist., 306 West 3d St., Los Angeles (Res., 1367 Spazier Ave., Glendale), Calif.

MASON, FAGAN BARR (Assoc. M. '31; M. '41), Senior Res. Engr., State Highway Dept., Box 481 (Res., 414 Southern St.), Corpus Christi, Tex.

MENDELL, DAN, JR. (Jun. '30; Assoc. M. '40), Civ. Engr., Humble Oil & Refining Co., Box 2180, Houston, Tex.

MISCH, FRANZ MARTIN (Jun. '28; Assoc. M. '40), Head Insp., S. P. Co., Redding, Calif.

NICHOLS, KENNETH DAVID (Jun. '34; Assoc. M. '41), Capt., Corps of Engrs., U.S. Army, Instr., Dept. of Civ. and Military Eng., U.S. Military Academy, West Point, N.Y.

NOFERI, LOUIS ERNEST (Jun. '29; Assoc. M. '41), With Board of Transportation, 250 Hudson St. (Res., 201 Prince St.), New York, N.Y.

OAKLEY, THOMAS DENTON (Assoc. M. '28; M. '41), Associate Engr., Corps of Engrs., U.S. Army, U.S. Engr. Office, Memphis, Tenn.

OLANDER, HARVEY CHESTER (Jun. '36; Assoc. M. '40), Engr., U.S. Bureau of Reclamation, Customs House (Res., 1150 Hudson St.), Denver, Colo.

PARK, CHARLES ABRAHAM (Assoc. M. '11; M.'41), Capt., U.S. Coast Guard, 14th and D Sts., S.E. (Res., 5126 Nebraska Ave., N.W.), Washington, D.C.

PARKINSON, CLYDE PHILIP (Jun. '39; Assoc. M. '41), Asst. Hydr. Engr., U.S. Geological Survey, 526 Federal Bldg., Albany, N.Y.

PLUMMER, HARRY CUSTER (Assoc. M. '28; M. '41), Director, Eng. and Research, Structural Clay Products Inst., 1756 K St., N.W., Washington, D.C.

QUADE, MAURICE NORTHROP (Jun. '27; Assoc. M. '30; M. '41), Structural Engr., Parsons, Klapp, Brinckerhoff & Douglas, 142 Maiden Lane, New York, N.Y. (Res., 20 Helen Ave., West Orange, N.J.)

SHAW, BARTON HARRINGTON (Jun. '39; Assoc. M. '41), Asst. Engr., U.S. Engr. Office, Box 1234 (Res., 2786 Sarita Pl.), Cincinnati, Ohio.

SIMPSON, WILLARD EASTMAN (Assoc. M. '22; M. '41), Pres., W. E. Simpson Co., 1446 Milam Bldg. (Res., 1211 West Woodlawn Ave.), San Antonio, Tex.

THOMPSON, MURRAY NIXON (Assoc. M. '27; M. '41), Flood Control Engr., Orange County Flood Control Dist., 706 North Main St. (Res. 1321 North Bristol St.), Santa Ana, Calif.

TUHUS, KENNETH OLSON (Jun. '37; Assoc. M. '41), Asst. Engr., U.S. Engrs., Wright Bldg. (Res., 4537 East 5th Pl.), Tulsa, Okla.

VAUGHAN, EVAN WILLIAM (Jun. '35; Assoc. M. '41), Chf. Soil Technician, The Panama Canal, Soils Laboratory, Miraflores, Canal Zone.

WALTHER, CARL HUGO (Jun. '39; Assoc. M. '41), Instr., Civ. Eng., George Washington Univ., 21st and H Sts., N.W., Washington, D.C.

WYLIE, MARSHALL JESSE (Jun. '32; Assoc. M. '40), Dist. Highway Engr., State Highway Dept. (Res., 101 Catron St.), Santa Fe, N.Mex.

REINSTATEMENTS

HASELTINE, THEODORE RAYMOND, Assoc. M., reinstated Feb. 15, 1941.

HAYLER, GUY WILFRID, Assoc. M., reinstated Feb. 25, 1941.

LAWTON, ELMORE GRENVILLE, Jun., reinstated Feb. 11, 1941.

LENG, HORACE GREELEY, Assoc. M., reinstated Mar. 6, 1941.

MATTHEWS, JAMES FREDERICK, Assoc. M., reinstated Feb. 11, 1941.

STORY, JOHN WILSON, Assoc. M., reinstated Mar. 5, 1941.

WENSTRAND, RALPH THEODORE, Assoc. M., reinstated Feb. 24, 1941.

WHITTIER, WILMOT EDGAR, M., reinstated Feb. 11, 1941.

WILLIAMS, BELMONT MURRAY, Jun., reinstated Mar. 4, 1941.

RESIGNATIONS

BARDIN, WILLIAM JOSEPH, Jun., resigned Feb. 17 1941.

BARNES, TED COLLINGS, Jun., resigned Feb. 11 1941.

BATES, WILLIAM JOURDAN, Jun., resigned Feb. 20, 1941.

BRUCK, LOUIS WILLIAM, M., resigned Feb. 20, 1941.

COPEN, MERLIN DENVER, Jun., resigned Feb. 17, 1941.

GOFSEYEFF, SAMUEL, Assoc. M., resigned Feb. 20, 1941.

HINCKS, HARVEY WELLMAN, M., resigned Mar. 5, 1941.

HUNTER, WILLIAM BISHOP, M., resigned Mar. 5, 1941.

LEVIN, ABRAHAM, Assoc. M., resigned Feb. 19, 1941.

THURING, ADOLPH CARL, Assoc. M., resigned Feb. 11, 1941.

UHRICH, MORRIS BORDNER, Jun., resigned Feb. 17, 1941.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

April 1, 1941 NUMBER 4

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

ARLEDGE, ALBERT ROSS (Assoc. M.), Pasadena, Calif. (Age 57) (Claims RCA 5.6 RCM 25.7) Sept. 1919 to date Tech. Asst. to Engr. of Design and Constr., Los Angeles (Calif.) Bureau of Power and Light.

BISHOP, LOREN CLARK, Cheyenne, Wyo. (Age 56) (Claims RCM 28.0) April 1939 to date State Engr. of Wyoming; previously City Engr. of Douglas, Wyo.

BRADFIELD, CURTIS GORDON, Baltimore, Md. (Age 37) (Claims RCA 2.8 RCM 13.2) July 1938 to date Civ. Engr., U.S. Coast Guard, Curtis Bay, Md.; previously Civ. Engr. with S. J. Martenet & Co., Civ. Engrs. and Surveyors, and Civ. Engr. and Land Surveyor on general engineering, both of Baltimore.

BURBANK, OSCAR FRANK, Worcester, Mass. (Age 62) (Claims RCM 22.8) June 1904 to date with State Civil Service, as Rodman and Asst. Engr., City Engr.'s Office, and (since May 1918) Supt. of Hope Cemetery.

DILLON, ROBERT EMMET, Boston, Mass. (Age 57) (Claims RCM 30.0) 1911 to date with Production Dept., Boston (Mass.) Edison Co., as Tech. Engr., Asst. Supt., Supt., and (since 1937) Vice-Pres. of Production and Eng.

DRESSER, FERDINAND JOHN CONRAD, Washington, D.C. (Age 57) (Claims RCA 11.0 RCM 23.0) July 1940 to date with Constr. Advisory Board, Office of Quartermaster General; 1922 to 1933 and Feb. 1937 to July 1940 Pres., The Dresser Co., Engrs. and Bldrs., Cleveland; in the interim with U.S. Govt.

FLETCHER, THOMAS, Baltimore, Md. (Age 52) (Claims RCA 18.8 RCM 11.2) 1912 to date with United Rys. & Elec. Co. of Baltimore (after 1935 Baltimore Transit Co.) as Draftsman, Field Engr., Shops Engr., Asst. Roadmaster, and (since 1938) Roadmaster.

FRANCIS, GEORGE WALDEN (Assoc. M.), Saginaw, Mich. (Age 45) (Claims RCA 5.4 RCM 15.1) March 1926 to date Cons. Engr. in private practice as The Francis Eng. Co.

HOBCH, CHARLES BEN, Little Rock, Ark. (Age 39) (Claims RCA 8.6 RCM 6.2) July 1933 to date Res. Engr., Arkansas Highway Comm.

HOMAN, EARL WILSON, Kansas City, Mo. (Age 42) (Claims RCA 7.9 RCM 9.7) Oct. 1934–March 1939 Partner, and April 1939 to date Owner, Horner and Wyatt, Cons. Engrs.

HOWLAND, ARTHUR EASTMAN, Los Angeles, Calif. (Age 47) (Claims RCA 4.8 RCM 15.2) Oct. 1940 to date Structural Engr., Wm. Simpson Constr. Co.; previously Structural Designer successively with Roy C. Wilson, Archt., Santa Paula, Calif., Manley W. Sahlberg, Structural Engr., U.S. Engr. Office, Ralph W. Stewart, Bridge Engr., and E. A. Evans, Structural Engr., all of Los Angeles, Calif.

ITJEN, EUGENE MILTON, Queens Village, N.Y. (Age 37) (Claims RCA 0.5 RCM 14.7) Oct. 1925 to date with City of New York, in various capacities with Board of Transportation, etc., and since June 1940 Asst. Engr., Dept. of Public Works.

JOHNSON, NATHAN CLARKE, Englewood, N.J. (Age 59) (Claims RCM 26.0) 1914–1940 Cons. Engr.

ITTER, CHARLES JUSTUS, Los Angeles, Calif. (Age 44) (Claims RCA 12.0 RCM 5.5) Dec. 1926 to date with Bureau of Water Works and Supply, Dept. of Water and Power, Los Angeles, as Topographic Draftsman, Jun. Civ. Engr., and (since June 1935) Asst. Civ. Engr.

LANDWEHR, WALDEMAR JOHN (Assoc. M.), Madison, Wis. (Age 37) (Claims RCA 3.6 RCM 9.1) Sept. 1934 to date Engr. for Madison (Wis.) Metropolitan Sewerage Dist.

LARSON, FRED HERMAN, Colville, Wash. (Age 38) (Claims RCA 4.1 RCM 10.0) Dec. 1939 to date with SCS as Engr.; previously Engr. and Supt. on erosion-control work in Iowa.

MCGILL, EDWIN HAMPTON, Santa Fe, N.Mex. (Age 54) (Claims RC 25.0) 1932 to 1933 Asst. Engr., and 1925 to 1932 and 1934 to date Location Engr., New Mexico Highway Dept.

OVIATT, EUGENE EDWARD, Hamden, Conn. (Age 49) (Claims RC 24.9) 1913 to date with New York, New Haven & Hartford R.R., as Rodman, Transitman, Asst. Engr., Track Supervisor, Div. Engr., Maintenance Engr., Engr., and (since 1931) Chf. Engr.

QUIRK, EDWARD PETER (Assoc. M.), Queens Village, N.Y. (Age 54) (Claims RCA 10.8 RCM 9.9) April 1936 to date Associate Valuation Engr., Public Service Comm., New York State; previously Examiner, St. Ry. Eng., Transit Comm., New York State.

ROBERTS, KENNETH CLARK (Assoc. M.), Fountain City, Tenn. (Age 41) (Claims RCA 9.0 RCM 5.0) Sept. 1934 to date Associate Structural Engr. and Senior Structural Engr., Design Dept., TVA.

TIPTON, ROYCE JAY (Assoc. M.), Denver, Colo. (Age 48) (Claims RCA 3.5 RCM 16.3) Nov. 1933 to date Cons. Engr. for State Engr. and Interstate River Comm., various Boards, Water-Conservation Districts, etc.

WAGNER, WILLIAM CHAUNCEY, Albuquerque, N. Mex. (Age 41) (Claims RCA 5.2 RCM 6.3) Sept. 1929 to Sept. 1934 Instructor in, Sept. 1934 to Sept. 1938 Asst. Prof., and Sept. 1938 to date Associate Prof., of Civ. Eng., Univ. of New Mexico.

WALTERS, FRANCIS PATRICK, Stapleton, N.Y. (Age 36) (Claims RCA 1.0 RCM 5.8) Nov. 1940 to date Specification Writer, Frederic R. Harris, Inc., New York City; previously Constr. Engr. and Supt., George F. Collins Co.; Office Engr., Estimator and Designer, E. W. Foley, Inc., Brooklyn, N.Y.; with Jersey Central R.R. Co., Jersey City, N.J., and Baltimore & Ohio R.R. Co., Staten Island, N.Y.

WELLONS, CHARLES MCCARTNEY, Bellevue, Pa. (Age 47) (Claims RC 22.0 D 21.4) April 1917 to date with U.S. Engr. Office in various capacities, since March 1923 Engr. and Senior Engr. in charge of Design Div.

ZEDER, FRED MORRELL, Detroit, Mich. (Age 55) (Claims RCA 9.0 RCM 20.0) 1924 to 1935 Vice-Pres., and 1935 to date Vice-Chairman of Board, Chrysler Corporation.

ZEIGLER, CHARLES FORREST (Assoc. M.), Leavenworth, Kans. (Age 43) (Claims RCA 4.5 RCM 15.0) Jan. 1930 to date Engr., Geiger & Rutherford, Gen. Contrs.

APPLYING FOR ASSOCIATE MEMBER

BEARDSLEE, EDWARD MCCLELLAND, Atlanta, Ga. (Age 30) (Claims RCA 2.6 RCM 7.1) Sept. 1940 to date with J. B. McCrary Eng. Corporation, Hinesville, Ga., as Chf. Draftsman, Chf. Engr., and (at present) Project Engr., Camp Stewart, in complete charge; previously Engr. Inspector, PWA.

BEVAN, ROBY BEDELL, Knoxville, Tenn. (Age 36) (Claims RCA 4.9 RCM 3.2) June 1933 to date with TVA as Senior Eng. Draftsman, Eng. Service Div., Prin. Eng. Draftsman, Ry. Sec., Asst. Structural Engr., Structural Sec., and (since Jan. 1939) Asst. Structural Engr., Mechanical Sec.

BISHOP, R. B., Diablo Heights, Canal Zone. (Age 32) (Claims RCA 3.0) April 1940 to date with the Special Engineers of The Panama Canal as Jun. Engr. (1 month) and Asst. Engr.; previously with U.S. Waterways Experiment Station, Vicksburg, Miss., as Laborer, Gauge Reader, Asst. Eng. Aide, Senior Eng. Aide, and Jun. Engr.

BONNER, JOSEPH PATRICK, Moscow, Idaho. (Age 35) (Claims RC 5.1) Feb. 1938 to date Associate Engr., SCS; previously with U.S. Geological Survey as Jun. Engr. and Asst. Engr.

BRUMLEY, DAVID JOSEPH (Junior), Knoxville, Tenn. (Age 31) (Claims RCA 5.0) Nov. 1934 to date with TVA as Asst. Eng. Aide, Jun. Engr., Jun. Hydr. Engr., and (since Jan. 1939) Asst. Hydr. Engr.

BRUMUND, GERRY HENRY (Junior), Sacramento, Calif. (Age 32) (Claims RCA 4.7) June 1936 to Jan. 1941 Senior Eng. Field Aid, and Jan. 1941 to date Jun. Bridge Engr., Bridge Dept., California Div. of Highways; previously Draftsman, Pacific Gas & Elec. Co., Sacramento.

BUNKER, WILLIAM BEEHLER (Junior), Managua, Nicaragua. (Age 30) (Claims RCA 1.0 RCM 2.3) June 1937 to date with U.S. Engr. Office, since July 1939 in Hydrographic Office, Nicaragua Canal Survey; previously graduate student.

CHENEY, DONALD LEROY, Helena, Mont. (Age 36) (Claims RCM 7.6) May 1928 to date with Montana Highway Dept., as Inspector, Chainman, Rodman, Instrumentman, Acting Project Engr., Project Engr., State Oiling Engr., Bituminous Engr., and (since March 1940) Constr. Engr.

CLARK, JOE CALHOUN, Marshall, Tex. (Age 41) (Claims RCA 11.2) July 1929 to date with Texas Highway Dept., in various capacities and (since Oct. 1937) Jun. Res. Engr.

CLINTON, FRANK MARK (Junior), Worland, Wyo. (Age 32) (Claims RCA 2.5) May 1937 to date with U.S. Bureau of Reclamation as Inspector, and (since March 1939) Asst. Engr.; previously Jun. Engr. and Hydrographer, U.S. Geological Survey, Tucson, Ariz.

COLE, HARRY, Diablo Hgts., Canal Zone. (Age 49) (Claims RCA 16.8 RCM 3.7) April 1934 to date with U.S. Engrs., as Asst. Engr., Associate Engr., and (since Oct. 1940) Engr.

CRAVEN, THOMAS DAVID, Laramie, Wyo. (Age 41) (Claims RCA 4.9 RCM 3.2) Feb. 1939 to date Gen. Supt., WPA, Albany County, Wyo.; June to Dec. 1934 Project Engr., Medicine Bow National Forest.

CROWLEY, BERNARD REUVELT, Commerce, Tex. (Age 35) (Claims RCA 9.0 RCM 0.7) Feb. 1928 to date with Texas Highway Dept., as Chainman, Rodman, Office Engr., Bridge Inspector, Instrumentman, Asst. Res. Engr., and (since June 1938) Jun. Res. Engr.

CUMMINS, THOMAS VINCENT (Junior), Denver, Colo. (Age 32) (Claims RCA 5.5) Aug. 1926 to date (until Oct. 1934 intermittently) with U.S. Geological Survey as Rodman, Eng. Field Aide, Jun. Topographic Engr., Asst. Topographic Engr., and (since Sept. 1940) Associate Topographic Engr.

DONNELLY, JACK ADEN (Junior), Pittsburgh, Pa. (Age 33) (Claims RCA 5.2 RCM 1.5) July 1929 to date with McClintic Marshall Contr. Co. (Bethlehem Steel Co.), in various capacities, since Feb. 1939 Asst. Works Engr., Leetsdale, Pa.

DUNHAM, JAMES WARING (Junior), La Canada, Calif. (Age 32) (Claims RCA 5.7) June 1929 to date with U.S. Engr. Dept., as Student Inspector, Jun. Engr., and (since Aug. 1937) Asst. Engr.

ELLIS, GENE EBER (Junior), Topeka, Kans. (Age 30) (Claims RCA 2.5 RCM 3.9) April 1937 to date Structural Field Engr., Portland Cement Association; previously Jun. Engr. and Senior Engr., WPA.

EVANS, WILLIAM HAROLD, Ellenville, N.Y. (Age 40) (Claims RCA 1.5) July 1940 to date Engr. Inspector, Grade IV, New York City Board of Water Supply, Lackawack, N.Y.; previously Jun. Engr., and Structural Draftsman, Consolidated Edison Co. and Affiliates, New York City.

FLORA, WALTER WILSON (Junior), Cheyenne, Wyo. (Age 28) (Claims RCA 4.0) 1937 to date Cons. Engr.; previously with Bridge Dept., Wyoming State Highway Dept.

FRITZ, HERBERT DANIEL (Junior), Burlington, Iowa. (Age 32) (Claims RCA 10.7) Nov. 1937 to date Maintenance Engr., Independent School Dist. of Burlington, Iowa; previously with Bureau of Agri. Eng., U.S. Dept. of Agriculture, as Jun. Civ. Engr., CCC Camp Supt., and Collaborator, Bureau and Univ. of Illinois Agri. Extension Service, Drainage Extension, etc.

GARNETT, RAYMOND RAITHEL (Junior), Los Angeles, Calif. (Age 32) (Claims RCA 6.8) Nov. 1932 to date with U.S. Engr. Office, successively as Sub.-Inspector, Inspector, Surveyman, and Jun. Engr.

GILLESPIE, ROBERT NEWTON, Allentown, Pa. (Age 37) (Claims RCA 11.6 RCM 3.3) June 1924 to date with Cement Gun Co., as Draftsman, Job Foreman, Res. Engr., Dist. Engr., Constr. Mgr., and Engr. on promotion of Gunite work, United States and Canada.

GRANT, FRANCIS WEIR (Junior), Shreveport, La. (Age 32) (Claims RCA 6.5) Oct. 1932 to date Eng. Dept., City of Shreveport, La., as Rodman, Chainman, Levelman, Transitman, Draftsman, Inspector and Engr.

HARDING, ROBERT CARNEGIE (Junior), Sells, Ariz. (Age 32) (Claims RCA 4.3) Nov. 1940 to date Asst. Agri. Engr., U.S. Indian Service; previously with SCS as CCC Camp Engr., Jun. Agri. Engr., and Asst. Agri. Engr.

HARRIS, ROBERT OLIN, Atlanta, Ga. (Age 35) (Claims RCA 4.0) Dec. 1939 to date with WPA of Georgia as Foremanship Training Supervisor, and (since Jan. 1941) Acting Safety Consultant; previously Senior Administrative Asst. (Regional Surveyor), RA, Montgomery, Ala.; Field Asst., Jun. Administrative Asst. and Senior Administrative Asst., Land Policy Sec., AAA (Land Utilization Div., USRA).

HART, ROBERT WINSTON (Junior), New Orleans, La. (Age 32) (Claims RCA 2.4) Jan. 1938 to Aug. 1940 Jun. Lighthouse Engr., U.S. Lighthouse Service and U.S. Coast Guard; Aug. 1940 to date Asst. Civ. Engr., U.S. Coast Guard; previously Civ. Eng. Aide, U.S. Bureau of Biological Survey; Foreman, U.S. Lighthouse Service.

HAYES, HOWARD MAXWELL (Junior), Moncks Corner, S.C. (Age 32) (Claims RCA 4.4) Oct. 1938 to date with Harza Eng. Co., as Party Chf., and (since Jan. 1940) Res. Engr.; previously with TVA.

HENSLEY, JAMES CARLISLE, Abilene, Texas. (Age 42) (Claims RCA 7.7 RCM 9.5) Nov. 1938 to date in private engineering practice, since Nov. 1939 as member of contracting firm, Childs & Hensley; previously Asst. City Engr., Abilene; Area Engr., WPA; with Texas Highway Dept.

HOFF, WILLIAM HENRY BARNES, Brownwood, Tex. (Age 36) (Claims RCA 1.8 RCM 8.4) Sept. 1940 to date with Koch & Fowler as Constr. Engr.; previously with Texas Highway Dept., as Instrumentman, Asst. Engr., Project Engr., Office Engr., and Dist. Office Engr., Dist. No. 23.

JARRELL, MILTON, Baltimore, Md. (Age 43) (Claims RCA 7.1) July 1925 to date with Office of Engr. of Bridges, Baltimore & Ohio R.R. Co. as Draftsman, Asst. Engr., and (since Jan. 1940) Chf. Bridge Draftsman.

JOHNSON, LEON RANDOLPH, Arlington, Va. (Age 34) (Claims RCA 4.3 RCM 7.0) 1939 to date in private practice as Pres., Southern Eng. & Constr. Co.; previously Engr.-Supt., J. Walter Williams Co., and Office Engr., J. A. LaPorte Constr. Co., both of Arlington, Va.

LEA, WILLIAM CHESTER, Dearborn, Mich. (Age 30) (Claims RCA 8.5) Oct. 1932 to date with Sun Oil Co., as Constr. Engr., and (since Dec. 1935) Regional Engr.

LETTS, JAMES OTIS, Rock Island, Ill. (Age 36) (Claims RCA 4.5) March 1934 to date with U.S. Engr. Dept., Rock Island Dist., Hydr. Sec., as Surveyman, Jun. Engr., and (since Dec. 1937) Asst. Engr.

MCARTHUR, THOMAS JOSEPH (Junior), Newburgh, N.Y. (Age 33) (Claims RCA 6.0) Nov. 1936 to date with Board of Water Supply as Engr. Asst., Grade 3, Engr. Inspector, Grade 4, and (since Oct. 1939) Asst. Engr., Grade 4; previously Inspector (tunnel construction), U.S. Engr. Dept., Ft. Peck, Mont.

MCGUINNESS, WILLIAM JAMES, Flushing, N.Y. (Age 39) (Claims RCA 10.0) Sept. 1940 to date with Dept. of Architecture, Pratt Inst., Brooklyn, N.Y., as Instructor, also Prof. Engr. handling structural changes to existing buildings; previously Constr. Inspector, FHA; Vice-Pres., Winninger & Selby Inc.; Maintenance Mgr., Brett & Wyckoff, Inc.

MOORE, JOHN STROTHER, Denver, Colo. (Age 54) (Claims RC 20.7 D 9.4) March 1908 to date with U.S. Bureau of Reclamation, as Jun. Engr., Asst. Engr., Associate Engr., and (since April 1931) Engr.

MORGAN, HAROLD WILLIAM, Birmingham, Ala. (Age 39) (Claims RCA 3.2 RCM 4.1) June 1923 to Sept. 1934, Sept. 1935 to June 1937 and Jan. 1940 to date with Virginia Bridge & Iron Co. (Virginia Bridge Co.), Roanoke, Va., as Structural Draftsman, Structural Engr., Asst. Constr. Engr., Res. Engr., and Constr. Engr.; in the interim with United Color & Pigment Corporation, Newark, N.J., Virginia Chemical Corporation and Southern Mineral Products Corporation, both of Piney River, Va.

NEWMAN, EDWIN MAHLON (Junior), Kansas City, Mo. (Age 32) (Claims RCA 1.1) May 1937 to date with Harrington and Cortelyou, Cons. Engrs., as Draftsman, Detailer, Res. Engr., Asst. Res. Engr., and (since Nov. 1940) Detailer and Checker; previously with Design Dept., Kansas Highway Comm., as Chainman, Senior Rodman, Instrumentman, and Jun. Draftsman.

PAPPIN, GORDON FRANCIS (Junior), Seattle, Wash. (Age 31) (Claims RCA 6.5 RCM 3.0) Sept. 1940 to date Quantity Survey Engr. and Estimator, Siems Drake Puget Sound; previously with Constr. Office, U.S. Indian Service, Salt Lake City, Utah, as San. Civ. Engr., and Supt. of Constr.

RICH, ALBERT BARZILLAI, North Quincy, Mass. (Age 35) (Claims RCA 4.6) May 1934 to date Designing Engr., Fay, Spofford & Thorndike, Engrs., Boston, Mass.

SALTZSTEIN, IRVING DAVID, Milwaukee, Wis. (Age 37) (Claims RCA 8.2 RCM 2.0) Oct. 1940 to date Engr., Plant Eng. Dept., A. O. Smith Corporation; previously with FPWA as Asst. Res. Engr., Inspector, and Res. Engr. Inspector; Asst. Supervisor, and Area Engr., WPA.

SMITH, LEWIS GORDY (Junior), Denver, Colo. (Age 32) (Claims RCA 3.2) March 1936 to date with U.S. Bureau of Reclamation as Jun. Engr., and (since Jan. 1938) Asst. Engr.

STUBBS, JAMES ARMSTRONG (Junior), Denver, Colo. (Age 33) (Claims RCA 5.0) Oct. 1933 to date with U.S. Bureau of Reclamation as Jun. Engr., Asst. Engr., and (since June 1938) Asst. Engr., Research, Materials and Testing Laboratory.

SULLIVAN, WILLIAM WATERS, Alexandria, Va. (Age 34) (Claims RCA 4.7) Jan. 1940 to date with U.S. Engr. Dept., Washington National Airport, as Asst. Chf., Chf., Constr. Sec., Operations Div., and since Oct. 1940 Chf. of Operations; previously Gen. Constr. Engr., U.S. Military Academy; with District of Columbia Highway Dept., as Chainman, Rodman, Transitman, and Asst. Engr.

T'ANG, CHEN-HSU (Junior), Ithaca, N.Y. (Age 30) (Claims RCA 1.2) Nov. 1940 to date Res. Doctor and Asst. in Hydraulics, Coll. of Eng., Cornell Univ.; previously graduate student; Visiting Engr., Shensi Irrigation projects; Engr., Yellow River Comm., Kaifeng, China.

THORNTON, WILLIAM CLINTON (Junior), Chicopee Falls, Mass. (Age 30) (Claims RCA 5.4) Sept. 1936 to date with U.S. Engr. Office as Jun. Engr., Constr. Supervisor, Asst. to Area Engr., etc., and at present Asst. to Res. Engr. on flood-wall construction.

APPLYING FOR JUNIOR

ABBOTT, JOHN ALFRED, JR., Hagerstown, Md. (Age 23) (Claims RC 0.3) June to July 1939 Asst. Engr., and Dec. 1940 to date Inspector of building construction, Whitman, Requardt & Smith; in the interim Eng. Aide, The Panama Canal, Balboa, Canal Zone; Jun. Eng. Aide, TVA.

CLARK, LUTHER DANIEL, Sherman, Tex. (Age 27) (Claims RCA 1.2) June to Nov. 1937, March 1938 to Jan. 1939, and July 1939 to date with WPA, as Asst. Supt., Supt. Office Engr., and (since July 1940) Asst. Supt. of construction of water-filtration plant for Denison, Tex.

COOKE, JAMES BARRY, San Francisco, Calif. (Age 25) 1939 B.S., Univ. of Calif.; May 1939 to date with Pacific Gas & Elec. Co., as Field Draftsman, Engr.-Clerk, and (since May 1940) Engr.'s Asst.

DAVIS, HUGH JOSEPH, Dallas, Tex. (Age 27) (Claims RCA 1.1) Sept. 1939 to date Instructor in Civ. Eng., Southern Methodist Univ.; previously Hydr. Engr., West Coast Power Co., Portland, Ore.; Eng. Apprentice, Apprentice in Purchasing Agent's Office, and Asst. on Eng. Corps., Pennsylvania R.R. Co.

DAY, HERBERT BORIS, San Benito, Tex. (Age 23) 1939 B.S. in Civ. Eng., Miss. State Coll.; Oct. 1939 to date with International Boundary Comm., as Jun. Hydr. Engr., Hydr. Sec., and (since Sept. 1940) Jun. Engr., Project Office; previously Rodman, Louisiana Highway Comm.

DOLLAR, HENRY, Lackawack, N.Y. (Age 23) Oct. 1939 to date Engr. Asst., New York City Board of Water Supply; previously Jun. Engr., National Bureau of Standards, Washington, D.C.

GRAYMAN, ROBERT, Cincinnati, Ohio. (Age 27) (Claims RCA 1.7) Nov. 1936 to date with U.S. Engr. Office as Eng. Draftsman, Jun. Engr., and (since Jan. 1941) Asst. Engr.; previously Student Engr., Specifications and Materials Sec., U.S. Bureau of Public Roads, Albany, N.Y.

HAMMOND, ROBERT JAMES, Maracaibo, Venezuela. (Age 23) Aug. 1939 to date Jun. Engr., The Lago Petroleum Corporation, Maracaibo, Venezuela; previously Jun. Engr., Federal Power Comm., Washington, D.C.

HARNED, EDWARD JOHNSON, Baltimore, Md. (Age 24) June to Sept. 1937 Jun. Civ. Eng. Aid, and Feb. 1939 to date Jun. Civ. Engr., U.S. Engr. Office; previously Asst. Civ. Eng. Aide, Soils Div., U.S. Waterways Experiment Station, Vicksburg, Miss.; Area Engr., NYA, Tupelo, Miss.

HULME, ARTHUR EDWARD, University, La. (Age 27) (Claims RCA 0.4) Aug. 1938 to date Jun. Engr. (Hydr.), State of Louisiana, Dept. of Conservation, Geological Survey; previously Rodman and Computer, Geophysical Service, Inc., Dallas, Tex.

INGRASIN, JAMES THOMAS, New York City. (Age 31) (Claims RCA 3.7) April 1939 to date Draftsman, with Security Steel Corporation, and (since June 1940) with F. R. Harris, Inc., Cons. Engr.; previously Engr., Ryan Constr. Co.; Engr., Draftsman and Gen. Foreman, WPA.

MATTHEWS, JOHN THOMPSON, Birmingham, Ala. (Age 28) Sept. 1936 to date Engr., Alabama Water Service Co.

PETERS, REINHARDT EDWARD, Norfolk, Va. (Age 26) July 1936 to date with U.S. Engr. Office as Inspector, Eng. Aide, and (since Aug. 1939) Jun. Engr.; previously Inspector, Wisconsin Highway Comm., Milwaukee, Wis.

RITCHEY, FORREST, Washington, D.C. (Age 26) (Claims RCA 1.4) July 1940 to date Jun. Structural Engr., Structural Sec., Constr. Quartermaster's Office, War Dept.; previously Asst. Eng. Aide and Eng. Aide, Structural Design Sec., U.S. Engr. Office, Tulsa, Okla.; Rodman, Oklahoma Highway Comm.

ROMANS, JAMES ROBERT, Boulder, Colo. (Age 24) (Claims RC 0.7) Sept. 1940 to date Instructor in Civ. Eng., Univ. of Colorado; previously Architectural Draftsman, Boise (Idaho) Payette Lumber Co.; Office and Field Engr., Morrison-Utah-Winston-Lawler, Contrs., Seminoe Dam, Wyo.

RUIZ GONZALO, JOSE MANUEL, San Juan, Puerto Rico. (Age 27) (Claims RCA 1.4) Oct. 1939 to June 1940 Eng. Aide, and Aug. 1940 to date Inspector, Gen. Constr., War Dept., U.S. Eng. Dept., Puerto Rico Dist.; previously with Govt. of Puerto Rico.

THOMAS, NATHAN O'BERRY, Jackson, Miss. (Age 24) (Claims RCA 0.5) Nov. 1938 to date Jun. Hydr. Engr., U.S. Geological Survey; previously Jun. Eng. Aide (Civ.), U.S. Engr. Office, Mobile, Ala.

WEDDING, PRESLEY ALLEN, Washington, D.C. (Age 28) 1937 B.S. in Civ. Eng., Univ. of Md.; March 1930 to Sept. 1931 Rodman and Instrumentman, and June 1937 to date Chf. of Party and Draftsman, Berrall & Locraft, Engrs.; Oct. 1933 to June 1934 Instrumentman and Chf. of Party, Maas Constr. Co. Baltimore, Md.

1940 GRADUATES

UNIV. OF ALA.
(B.S. in C.E.)

KARP, WILLIAM BUBBLES — Age (22)

UNIV. OF ARIZ.
(B.S. in C.E.)

DENN, MARTIN MICHAEL — (26)

UNIV. OF ARK.
(B.S. in C.E.)

HALL, JOHN ATKINS — (27)

BROOKLYN POLY. INST.
(B.C.E.)

CUTLER, LOUIS — (24)

GEORGIA SCHOOL TECH.
(B.S. in C.E.)

ORRIN, ROBERT CARLTON — (23)

UNIV. OF MICH.
(B.S. in C.E.)

SPODEN, HAROLD THIES — (23)
WALTHER, WILLIAM EDWIN — (27)
(M.S. in Eng., Univ. of Missouri, to be conferred in June 1941)

UNIV. OF NEBR.
(B.S. in C.E.)

GILLAN, GERALD KEITH — (23)

UNIV. OF WIS.
(B.S. in Civ. Eng.)

KRYSHAK, JOSEPH STANISLAUS — (23)

1941 GRADUATES

COLL. OF CITY OF N.Y.
(B.C.E.)

DALY, WILLIAM JOSEPH — (21)
NICKELSBERG, ROBERT SIDNEY — (21)

AGRI. & MECH. COLL. OF TEX.
(B.S.)

HANCOCK, J. D. — (24)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Personnel Service, Inc., with offices in Chicago, Detroit, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 132 of the 1940 Year Book of the Society. To expedite publication, notices should be sent direct to the Personnel Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago, Detroit, or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CONSTRUCTION ENGINEER; M. Am. Soc. C.E., 1924; heavy construction; concrete, masonry, and earth-fill dams; river and harbor improvements; hydraulic dredging; wide experience and acquaintance in Latin-America; have just completed ten-million-dollar construction project for federal government. C-820.

CONSTRUCTION AND INDUSTRIAL ENGINEER; M. Am. Am. Soc. C.E.; B.S., 1911, C.E., 1918, University of Maine; 20 years experience—much of it on heavy construction; thoroughly experienced in planning, designing, specifications, purchasing; amiable labor supervisor. Now employed by U.S. government, but desires position offering more responsibility. Available two weeks notice. C-827.

CONSTRUCTION ENGINEER; Jun. Am. Soc. C.E.; age 30; graduate of technical school in structural engineering; five years field experience in supervision of construction of schools and power plants; prefers New England location with small architectural or engineering organization, or to be in charge of maintenance or building program of educational institution; now in Virginia. C-828.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; graduate licensed engineer with 24 years experience on buildings, highways, railroads, shipyards, and surveys, and in executive positions. C-829.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 24 years executive experience on heavy construction work as the representative of the contractor; is desirous of making a contact with a contracting organization which is interested in such work as excavations, foundations, tunnels, subways, dry docks, and substructure work of large caliber. Location immaterial. C-830.

DESIGN

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; civil engineering graduate, Rensselaer Polytechnic Institute, 1935; desires position with engineering firm or industry; 6 years with civil engineering firm—design and construction; supervision of pavements, sewers, water mains, sewage disposal; surveys; drafting. L.S. license. Location immaterial. Salary reasonable. C-821.

CIVIL ENGINEER, Jun. Am. Soc. C.E.; 31; married; B.S.C.E., 1933; registered; 7 years office experience in design of bridges and viaducts; wishes permanent position with opportunity for advancement; available on short notice to present employer. C-831.

EXECUTIVE

GRADUATE CIVIL ENGINEER; M. Am. Soc. C.E.; experienced executive in municipal work.

railroad work, design and field supervision of all kinds of engineering structures, including bridges, walls, docks, bulkheads, streets, sewers, etc. Location preferred, East. C-832.

Junior

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; B.S., Massachusetts Institute of Technology, 1936; some training in business administration and graduate work in civil engineering; 4 years varied office experience on bridges and structures; 9 months office experience on public land surveys. Desires junior executive position in any branch of civil engineering; will travel. C-822.

Research and Teaching

ARCHITECTURAL ENGINEER; Jun. Am. Soc. C.E.; 28; B.S., 1934; M.S., 1936, architecture; M.S., 1938, architectural engineering; Ph.D. (major in architectural engineering, minor in engineering mechanics) expected in June 1941; registered architect; 3 years with architectural firms in this country and abroad; 4 years research and testing; faculty member in charge of timber research. Available July 1. C-825.

Teaching

ASSISTANT PROFESSOR; Jun. Am. Soc. C.E.; age 32; married; B.S.C.E., M.S.C.E., and C.E. degrees; registered civil and structural engineer; 11 years teaching experience, mainly surveying and structures; also taught courses in highways, hydraulics, mechanics, and strength of materials one semester; $2^1/_4$ years practical experience in structural detailing, design, surveying, and inspection. C-823.

PROFESSOR OF MECHANICS AND MATERIALS; Assoc. M. Am. Soc. C.E.; registered civil, mechanical, and structural engineer and surveyor; graduate study beyond M.S. degree in C.E.; 8 years engineering practice, including design and supervision; 15 years teaching mechanics, materials, surveying, drafting, structures, and as department head. Will consider executive responsibility or specialized teaching in mechanics and materials. C-824.

INSTRUCTION IN CIVIL OR HYDRAULIC ENGINEERING; Jun. Am. Soc. C.E.; B.S.C.E.; M.S., C.E.; 8 years successful teaching experience as instructor and assistant professor at one college. Professional experience in flood control and hydrological investigations; $1^1/_2$ years with public utility organization. Would consider teaching or professional opening. C-826.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room, will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

ANALYTICAL MECHANICS FOR ENGINEERS, 3 ed. rewritten. By F. B. Seely and N. E. Ensign. John Wiley & Sons, New York, 1941. 450 pp., diagrs., charts, tables, 9 × 6 in., cloth, $3.75.
The principles of mechanics essential for engineers are presented in four parts: Statics, kinematics, kinetics, and a group of special topics. The aim has been to present these principles clearly, to develop them from common experience, to apply them to practical problems, and to emphasize their physical interpretations. A new chapter on mechanical vibrations and many new problems have been included in this edition.

COMMERCIAL TIMBERS OF THE UNITED STATES. By H. P. Brown and A. J. Panshin. McGraw-Hill Book Co., New York, 1940. 554 pp., illus., diagrs., tables, $9^1/_2$ × 6 in., cloth, $5.
The first half of this comprehensive work is devoted to a full exposition of the structure of wood with special attention to identification features. Two keys are then given for the identification of the more important commercial woods of the United States—one based on characters visible to the naked eye and the hand lens, the other on microscopic features. The descriptions by species record and explain important uses, and selected references are given. There is a glossary.

CROSBY-FISKE-FORSTER HANDBOOK OF FIRE PROTECTION, 9 ed. Edited by R. S. Moulton. National Fire Protection Association, Boston (Mass.), 1941. 1308 pp., illus., diagrs., charts, tables, 7 × $4^1/_2$ in., leather, $4.50.
This comprehensive manual contains essential information on all phases of fire prevention and fire protection. All new developments in hazards, protective equipment, and methods, which have been made during the five years since the last edition, are included in this revision, to continue the policy of providing an authoritative review of accepted practice.

FOURIER SERIES AND BOUNDARY VALUE PROBLEMS. By R. V. Churchill. McGraw-Hill Book Co., New York and London, 1941. 206 pp., diagrs., tables, 9 × 6 in., cloth, $2.50.
This book presents an introductory treatment of the Fourier series and their application to the solution of boundary-value problems in the partial differential equations of physics and engineering. The aim is to give the student a conception of orthogonal sets of functions and their use in the classical process of solving these problems. References and review problems are included.

Great Britain. Home Office (Air Raid Precautions Department). Air Raid Precautions Handbook No. 5A, 1 ed. BOMB RESISTING SHELTERS. London, His Majesty's Stationery Office, 1939. 6 pp., diagrs., $13^1/_2$ × 8 in., paper. (Obtainable from British Library of Information, 50 Rockefeller Plaza, New York, 15 cents.)
This pamphlet contains the recommendations of a defense committee with regard to structures which would afford protection against direct or near hits by heavy bombs. Designs are presented in accordance with these recommendations.

Great Britain, Department of Scientific and Industrial Research. BUILDING RESEARCH, WARTIME BUILDING BULLETIN No. 10. General Principles of Wartime Building. 28 pp. BUILDING RESEARCH, WARTIME BUILDING BULLETIN No. 11. Precautions for Concreting and Bricklaying in Cold Weather. 12 pp. His Majesty's Stationery Office, London, 1940. Diagrs., charts, tables, 11 × $8^1/_2$ in., paper. (Obtainable from British Library of Information, 50 Rockefeller Plaza, New York, 30 cents each Bulletin.)
In No. 10 the main principles governing wartime building are stated, and there is a long section on economy in the use of materials and efficiency in design. In No. 11 special methods are suggested for concreting and bricklaying under unusually cold weather conditions, in order to avoid delays.

Great Britain. Home Office (Air Raid Precautions Department). Air Raid Precautions Memorandum No. 10 (1 ed.). PROVISION OF AIR RAID SHELTERS IN BASEMENTS. London, His Majesty's Stationery Office, 1940. 38 pp., diagrs., tables, 10 × 6 in., paper. (Obtainable from British Library of Information, 50 Rockefeller Plaza, New York, 10 cents.)
Rules are given for the number of persons to be accommodated, the degree of protection recommended, and for strengthening floors above basements to support debris loads. The greater part of the pamphlet, Part IV, describes the provision of shelters in basements, with examples of methods that can be used in buildings of the domestic type.

MASTERING MOMENTUM. By L. K. Sillcox. Simmons-Boardman Publishing Corp., New York, 1941. 274 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $2.50.
Modern transport trends are discussed with particular reference to their influence upon the equipment of American railways. Current developments in train operation and braking, wheels, axles, trucks, and draft gear, which will improve control, wear factors, and riding quality, are described. Illustrations and reaction graphs of various brake systems are appended.

POWER IN TRANSITION. By E. R. Abrams. Charles Scribner's Sons, New York, 1940. 318 pp., maps, tables, $8^1/_2$ × $5^1/_2$ in., cloth, $3.
The development of the electrical utilities is briefly described, and the growing tendency toward public control is considered. Some sixty major power projects are analyzed, their history through Congress is traced, engineering problems are discussed, and the resources, requirements, and expectations of the several regions to be served are carefully detailed. Probable effects of these developments of the national power policy are briefly pointed out in a final chapter. There are chapter bibliographies.

PRACTICAL SOLUTION OF TORSIONAL VIBRATION PROBLEMS, Vol. 1, 2 ed. By W. K. Wilson. John Wiley & Sons, New York, 1940. 731 pp., illus., diagrs., charts, tables, 9 × $5^1/_2$ in., cloth, $8.
The principles and computation details of torsional vibration are presented in a manner suitable for everyday reference. The extensive revision and enlargement of the new edition necessitated two volumes, of which the first covers general principles, natural frequency calculations, equivalent oscillating systems, flexible couplings, geared systems, and the determination of stresses at non-resonant speeds. There is a bibliography.

(THE) RAILROAD PROBLEM AND ITS SOLUTION. By J. E. Muhlfeld. Devin-Adair Co., New York, 1941. 290 pp., illus., charts, tables, 9 × $5^1/_2$ in., cloth, $3.
The author presents, in the first half of the book, a detailed group of recommendations concerning what those in control and in charge of the railroads should do, what outside help is needed, and from whom this help should be secured. The second part contains supporting information: Existing conditions and statistical data for railroad equipment; traffic and financing; and brief reference to the activities of other transportation methods.

SIMPLIFIED DESIGN OF ROOF TRUSSES FOR ARCHITECTS AND BUILDERS. By H. Parker. John Wiley & Sons, New York, 1941. 195 pp., diagrs., tables, 8 × 5 in., leather, $2.75.
The basic principles and methods underlying the design of the common types of roof trusses are presented for the layman. The principles of graphic statics are first discussed, as an introduction to the determination of stresses in roof trusses. The last two chapters deal with the practical design of timber and steel trusses.

(THE) SOCIAL RELATIONS OF SCIENCE. By J. G. Crowther. Macmillan Co., New York, 1941. 665 pp., diagrs., $8^1/_2$ × $5^1/_2$ in., cloth, $3.50.
The progress of civilization is examined in order to determine the part played by science. The author discusses the reasons for the existence of the scientific attitude, the contributions to everyday life resulting from scientific methods, the position of the scientist in the present social scheme, and the interrelations between society and science through the ages. He concludes with suggestions for creating an effective social policy for science. References accompany many chapters.

STRESS ANALYSIS AND DESIGN OF ELEMENTARY STRUCTURES. By J. H. Cissel. John Wiley & Sons, New York, 1940. 335 pp., illus., diagrs., charts, tables, $9^1/_2$ × 6 in., cloth, $4.
Fundamental and practical material which would generally be of value to an engineer in any field is presented in this textbook, which is primarily intended for engineering students other than civil. The section on stress analysis covers external forces and loads, graphic statics, beams, trusses, masonry structures, and foundations. The elementary design section covers structural fastenings and connections, timber, steel, and reinforced concrete beams and columns.

TEMPERATURE; ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY. Papers presented at a Symposium held in New York City, November 1939, under the auspices of the American Institute of Physics with the cooperation of the National Bureau of Standards, National Research Council. Reinhold Publishing Corp., New York, 1941. 1362 pp., illus., diagrs., charts, tables, maps, $9^1/_2$ × 6 in., cloth, $11.
This symposium contains 125 papers by eminent engineers, metallurgists, physicists, physicians, and biologists. It presents thorough descriptions of all phases of temperature technique and theoretical treatment of the thermodynamics and physics which underlie the various temperature scales, and includes such topics as low-temperature cancer therapy, cooling of concrete structures, high-temperature arcs, and molten steel pyrometry. There are bibliographies and a brief glossary of technical terms.

THERMODYNAMICS, 2 ed. By H. A. Everett. D. Van Nostrand Co., New York, 1941. 466 pp., diagrs., charts, tables, $9^1/_2$ × 6 in., cloth, $3.75.
This college textbook covers thoroughly the fundamentals of the subject in accordance with the author's experience as a teacher. Various phases are discussed in the light of modern developments in the field, the most recent of which have been incorporated in the new edition.

WELDING METALLURGY, Vols. 1 and 2. By O. H. Henry and G. E. Claussen. American Welding Society, New York, 1940. 359 pp., illus., diagrs., charts, tables, 8 × 5 in., cloth, $1.50.
Intended to familiarize members of the welding industries, including fabricators and designers, with the metallurgical aspects of the welding process, this book deals with the structure, properties, and composition of welded materials. It shows how the steel is affected by varied conditions of heat and stress, explains heat treatment procedure, and points out the way in which metallurgy can be used to control the welding process.

Zürich, Eidgenössische Technische Hochschule. Institut für Baustatik, Mitteilung No. 11. BEITRÄGE ZUR THEORIE UND BERECHNUNG VON BALKENBRÜCKEN AUS EISENBETON, by M. Hilal. Verlag A. G. Gebr. Leemann & Co., Zürich and Leipzig, 1940. 208 pp., illus., diagrs., charts, tables, 9 × 6 in., paper, 9 rm. or 15 Swiss frs.
The theory and calculation of reinforced concrete girder bridges, including continuous beam construction, are thoroughly discussed with particular reference to problems met in practice. The last chapter presents confirmation of previously determined agreement between calculated values and actual test results on reinforced concrete beams.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Publications (Except Those of the American Society of Civil Engineers) in This Country and Foreign Lands

Selected items for the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page to members of the Founder Societies (30 cents to all others), plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

ARCH, DESIGN. Design of Multi-Span Arch Bridges on Elastic Piers, J. J. Leeming. *Structural Engr.*, vol. 18, no. 2, Dec. 1940, pp. 723–738. Theoretical mathematical discussion of design of multi-span arch bridges on elastic piers, with special reference to method based on principle of superposition and theorem of strain energy; effect of temperatures and settlement of piers. Bibliography.

BASCULE, OHIO. Lorain Bascule Sets New Span Record. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, pp. 742–744. Construction of foundation and superstructure of 333-ft 4-lane double-leaf bascule bridge at Lorain, Ohio, featuring location of operating machinery in centers of piers; use of iron ore as aggregate for concrete of counterweights; driving of steel H-piling to hard shale.

HIGHWAY, STRENGTHENING. One of Twenty-Four Hundred. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 118–119. Method of strengthening floor of substandard old wrought-iron through truss of Baltimore type, 155 ft long, over Green River near Greenfield, Mass., built in 1895.

PONTOON, SEATTLE, WASH. Problems Presented by Lake Washington Floating Bridge, C. E. Andrew. *Am. Concrete Inst.—J.*, vol. 12, no. 3, Jan. 1941, pp. 253–268. Problems of design and construction resulting from use of concrete in construction of Lake Washington floating bridge; details of reinforced concrete pontoons; construction and launching of pontoons; pontoon connections; anchorage; features of retracting span for ship passage.

PONTOON, TURKEY. Die Gazubruecke ueber das Goldene Horn in Istanbul, A. Paul, Eby and Hammer. *Bauingenieur*, vol. 21, no. 43/44, Nov. 30, 1940, pp. 333–343, supp. plate. Description of mechanical and electrical equipment for operation of new steel-truss pontoon bridge over Golden Horn in Istanbul, Turkey; features of abutment foundations and of roadway; erection process; testing of bridge.

SUSPENSION, AERODYNAMIC EFFECT. Aerodynamic Action on Wires and Bridges, B. D. Mills, Jr. *Eng. News-Rec.*, vol. 126, no. 5, Jan. 30, 1941, pp. 167–168. Study of models illustrating probable movements of Tacoma Narrows Bridge preceding its collapse, which may have involved one or more of three aerodynamic phenomena—viz., galloping, wind eddy vibration, and flutter. Bibliography.

SUSPENSION, FAILURE. Collapse of Tacoma Bridge. *Western Construction News*, vol. 15, no. 12, Dec. 1940, pp. 403–406. Study of failure of deck on Tacoma Narrows suspension bridge, indicating that disaster was caused by aerodynamic instability; design details of deck; principle dimensions of major suspension bridges; reconstruction plans.

SUSPENSION, FAILURE. Stability Formula for Tacoma Bridge, J. H. A. Brahtz. *Eng. News-Rec.*, vol. 126, no. 5, Jan. 30, 1941, pp. 154–155. Letter to editor presenting theoretical mathematical discussion of possible cause of failure of Tacoma Narrows suspension bridge.

SUSPENSION, STABILIZATION. Stays and Brakes Check Oscillation of Whitestone Bridge. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, pp. 750–752. Discussion of design and effect of diagonal stay ropes extending from tower tops to deck being installed on Whitestone Bridge, New York, to complete system of damping devices to check vertical movements of suspended structure; observations on bridge and model; model test findings.

SUSPENSION, STABILIZATION. Two Recent Bridges Stabilized by Cable Stays. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, pp. 752–754. Discussion of observed movements and effect of stabilizing devices on Thousand Islands Bridge over St. Lawrence River in New York and Deer Isle Bridge in Maine; stabilizing installations include long diagonal stays extending upward to cables, short diagonals at midspan, and stays in side spans.

CITY AND REGIONAL PLANNING

AERIAL PHOTOGRAPHY. Uses of Air Photography in Planning. *Pennsylvania Planning*, vol. 7, no. 3, Nov. 1940, pp. 3–7. General discussion of value of aerial photography surveys as basis for regional planning.

HIGHWAY SYSTEMS. Planning Sessions. *Am. Road Bldrs.' Assn.—Proc.*, Mtg. Jan. 29–Feb. 2, 1940, pp. 714–773. Symposium of following papers: Planning for Future Highway Legislation, G. M. Balfour; Planning of Mississippi River Parkway, R. B. Brooks; Aviation Fields for Peace or War, S. S. Hanks; Planning for Traffic Safety and Convenience, B. W. Marsh; Planning Studies in Missouri, J. B. Butler; Planning Progress in My County, A. N. Buck; Planning Progress in My County, D. M. Campbell; and Planning Progress in My County, L. O. Marden.

HOUSING, AUSTRIA. Die Entwicklung des Wiener Wohnungsbaues, R. Rainer. *Zentralblatt der Bauverwaltung*, vol. 60, no. 45, Nov. 6, 1940, pp. 728–734. Review of housing construction in Vienna, Austria, since sixteenth century, with special reference to developments during twentieth century.

HOUSING, MEMPHIS, TENN. Some Trends in Public Housing, L. M. Graves and A. H. Fletcher. *Am. J. Pub. Health*, vol. 31, no. 1, Jan. 1941, pp. 65–71. Review of $2^1/_2$ years of public-subsidized housing progress in Memphis, Tenn.; demolishing dilapidated dwellings as means of improving housing conditions; development of comprehensive city housing plan; slum shifting.

POST-WAR. Problems of Building Reconstruction, D. E. E. Gibson. *Roy. Soc. Arts—J.*, vol. 89, no. 4577, Dec. 27, 1940, pp. 71–79, (discussion) 79–81. Outline of possible solution to problem in Great Britain; at present there is tendency for populations to converge in few great centers, leaving countryside and its natural industries to decay; it should be possible, with grid and cheap electricity, to have network of clean healthy towns, small enough to be within calling distance of country, and large enough to provide collective facilities for decent cultured living.

CONCRETE

CEMENT, CONSERVATION. Economical Use of Cement. *Engineering*, vol. 150, no. 3907, Nov. 29, 1940, p. 430. Excerpts from pamphlet issued by Building Research Station, Watford, Herts, for use of architects, engineers, contractors, and foremen, dealing with ways and means of securing economy on site.

CONSTRUCTION. Advances in Uses of Concrete in Transportation, M. D. Catton. *Am. Soc. Testing Matls.—Symposium*, Mtg. Mar. 6, 1940, pp. 52–56. Review of concrete construction in association with development and building in highway, railway, and airport engineering.

CONSTRUCTION, COLD WEATHER. Rapid-Hardening Concrete in Cold Weather, S. Gottlieb. *Concrete*, vol. 48, no. 12, Dec. 1940, pp. 33 and 39. Possibility of having to make greater use of quick-hardening concrete, especially in cold weather, is discussed as situation arising from war conditions; analysis of aluminous cement. From *Cement & Lime Mfr.*, date not specified.

CONSTRUCTION, COLD WEATHER. Reinforced Portland Cement Concrete in Cold Weather, R. V. Allin and H. H. Turner. *Cement & Lime Manufacture*, vol. 13, no. 11, Nov. 1940, pp. 198–203. Report on original experiments for obtaining approximate working rules for pre-heated concrete construction applicable to climate of Great Britain; conservation of heat; approximate temperatures of mixing water for preheating concrete. Bibliography.

DISINTEGRATION. Concrete Exposed to Sulphur Water, J. S. Nelles. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 441–452. Progress report on Detroit Edison Company tests showing condition of concrete specimens of different mixes, admixtures, and cements, after 12-year exposure completely submerged in flowing sulphur water; compressive strength curves; extent of disintegration; recommendations.

DISINTEGRATION. Good Concrete Stays Good in New York Sea Water, L. C. Hammond. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, pp. 832–834. Survey of harbor structures at New York City revealing that disintegrated concrete can be traced to poor design or construction; performance of precast piles and precast bulkhead blocks.

HOUSES, LOW COST. Ida B. Wells Low-Cost Housing Project in Chicago, C. A. Metz. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 461–472. Principal elements of design and construction of low-cost housing group of 125 buildings of fireproof construction in Chicago—1,662 dwelling units, 6,901 rooms—at cost per room of \$990; features of reinforced concrete frame construction; clay tile filler and concrete joists with clay tile soffits and 2-in. concrete top slab; contractor's cost per sq ft of floor area.

LIGHT WEIGHT. Design of Light-Weight Zonolite Concrete Mixes, G. P. Tschebotareff. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 509–515. Results of tests with light-weight Zonolite concrete mixes, illustrating peculiarities of such mixes which necessitate special approach to problem of their design; determination of advisable water content.

MIXING. Twelve-Year Record of Concrete Mixtures, V. L. Glover. *Am. Concrete Inst.—J.*, vol. 12, no. 3, Jan. 1941, pp. 269–279. Comparative study of records of Illinois Division of Highways demonstrating superiority of mortar voids method over volumetric proportioning of pavement concrete; flexural strength of concrete; strength comparisons for gravel and crushed stone concrete; cement factors; mortar factors.

ROADS AND STREETS, RHODE ISLAND. Concrete and Bituminous Macadam Used on Heavily Traveled Road. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 98–100. Design and construction of short-cut highway from Westerly to Providence, R.I., on which concrete is used as paving for heavily traveled lanes and bituminous macadam is laid on less used center lanes and on shoulders; removal of old concrete pavement; concrete paving.

DAMS

ACCIDENT PREVENTION. Two Miles of Hazard, J. E. Farr. *Nat. Safety News*, vol. 43, no. 2, Feb. 1941, pp. 12–13 and 74. Notes on safety precautions taken in construction of reinforced concrete curtain wall at south end of Kingsley Dam of Central Nebraska Public Power and Irrigation District; purpose of curtain wall is to prevent seepage around end of dam through porous material of abutment.

CONCRETE GRAVITY, CALIFORNIA. Friant Dam Concreting System. *Western Construction News*, vol. 15, no. 12, Dec. 1940, pp. 412–416. Description of trestle 2,200 ft long, derricks, revolving trains and other equipment for placing 2,200,000 cu yd of concrete in construction of Friant Dam of Central Valley Project, California, which will be 3,430 ft long and 320 ft max height; concrete mixes; foundation problems; batching controls and equipment.

CONCRETE GRAVITY, NEW MEXICO. Effect of Materials on Cracking Tendency in Dams, S. L. Meyers. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 517–520. Discussion of factors influencing formation of cracks in concrete gravity structure of Conchas Dam in New Mexico, having maximum height of 235 ft.

EARTH, CALIFORNIA. Foundation Unwatering Methods Used at Prado Dam. *Eng. News-Rec.*

vol. 125, no. 25, Dec. 19, 1940, p. 821. Preparation of foundation, including unwatering, for Prado earth fill dam in Southern California, having crest length of 2,280 ft and maximum height of 105 ft; description of pumping installation for removal of water for foundation site.

EARTH, SOUTH DAKOTA. Construction History and Technical Details of Sheridan Dam, B. F. Powell. *Black Hills Engr.*, vol. 26, no. 3, Dec. 1940, pp. 180–196. Methods and equipment used in construction of earth dam near Rapid City, S.Dak., having maximum height of 126 ft and length of 850 ft.

FOUNDATIONS. Underpinning Austin Dam, G. L. Freeman and R. B. Alsop. *Eng. News-Rec.*, vol. 126, no. 5, Jan. 30, 1941, pp. 180–185. Methods used in exploration and reconstruction of foundation of failed Austin Dam, Texas, before rebuilding of superstructure; underpinning and grouting of voids under its base; process involves about 86,000 lin ft of drilling and consumption of 80,000 sacks of cement.

FLOOD CONTROL

DEFENSE AGAINST FLOODS. How to Cheat Floods, G. W. McBride. *Food Industries*, vol. 13, no. 2, Feb. 1941, pp. 35–37. Ways to minimize damage if, and when, spring floods threaten plant; what to do when water recedes; planned action important; plan outlined is for defense against slowly rising flood, for which preparations may be made over several days; if plant is located on small stream or in valley with only narrow flood plain, preparations may have to be made in matter of hours. Bibliography.

FLOOD DAMAGE. Floods at Champion Fibre Plant, F. V. Doutt. *Tenn. Valley Engr.*, vol. 1, no. 10, Jan. 1941, pp. 5–6 and 16. Damage by floods during Aug. 1940 to property of Champion Paper and Fibre Co., Canton, N.C.; article gives nature of flood damage, methods used to correct it, and methods of cleaning up after flood.

FLOODS, DISCHARGE. Abnormal Rainfall in Texas. *Eng. News-Rec.*, vol. 126, no. 1, Jan. 2, 1941, p. 21. Data on peak discharges of Colorado River in Texas during flood of June 29–30, 1940, due to rainfall that totaled as much as 20 in. in 36-hour period.

MISSISSIPPI RIVER. Bonnet Carré Spillway on Mississippi River. *Engineering*, vol. 150, nos. 3907 and 3909, Nov. 29, 1940, pp. 421–422 and 430, and Dec. 13, pp. 465–466, supp. plates. Illustrated description of flood protection works erected to afford further protection to New Orleans, at point some 32 miles above city by river; it is provided with controlled openings by means of which 250,000 cu ft per sec of flood may be released and pass to Gulf of Mexico via Lake Pontchartrain. See also *Engineering Index* 1938, p. 490.

FLOW OF FLUIDS

FLOW OF PLASTIC MATERIALS. Flow of Mud and Sludge, H. E. Babbitt. *Ill. Soc. Engrs.—Annual Report*, vol. 15, no. 2., Apr. 1940, pp. 76–84. Discussion of laws of flow of mud, sewage sludge, and other plastic and pseudo-plastic materials; fundamental formulas and their practical applications.

FLOW OF WATER. Flow of Water in Pipes and Open Channels, R. T. Hancock. *Min. Mag.*, vol. 63, no. 3, Dec. 1940, pp. 289–293. Mathematical discussion of simplified method of solving hydraulic problems; method is based upon collection of pressure loss per unit of length, pipe diameter of length, pipe diameter or mean channel radius, velocity of flow, density of fluid, and viscosity into two groups, known as Reynolds Number and Resistance Coefficient; sixth variable is term for friction; logarithmic tabulations of values and examples of use.

FLOW OF WATER, MEASUREMENT. Measuring Flow in Open Channels, H. G. Wilm. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, p. 754. Description of simple instrument for determining depth and velocity head at various points of streams of small volumes of flow containing some bedload, silt, and trash, consisting of 1 by 3-in. staff of strong wood, one edge of which is sharpened by beveling from both sides.

PIPES. Flow of Muds, Sludges, and Suspensions in Circular Pipe, D. H. Caldwell and H. E. Babbitt. *Indus. & Eng. Chem.*, vol. 33, no. 2, Feb. 1941, pp. 156–171. Theoretical analysis of flow of sludges in circular pipe; equations developed and verified for determining friction losses for plastic flow and for turbulent flow in circular pipe; equation for determination of critical velocity, together with experimental verification; methods of determining significant constants in plastic flow and critical velocity equations described. Bibliography. Before Am. Inst. Chem. Engrs.

FOUNDATIONS

CAISSONS, CONSTRUCTION. Caisson Sinking with Job-Made Tools, R. F. Mirick. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, pp. 746–748. Description of job-made equipment assembled for sinking of 10 by 20-ft concrete caisson for Imhoff tank for sewage works at Killdeer, N.Dak.; righting and sealing of caisson; bentonite injection equipment used in tightening ground for sealing concrete caisson.

OFF-SHORE OIL WELL DRILLING. Caisson-Type Marine Foundations Support Derricks in Lake Maracaibo, J. P. O'Donnell. *Oil & Gas J.*, vol. 39, no. 33, Dec. 26, 1940, pp. 76–77 and 162. Practice of Lago Petroleum Corp. on concession in District of Bolivar, Venezuela; use of wood piles is impractical because of insufficient lengths and because of presence of teredos; reinforced concrete piles used vary from 30 to 135 ft in length and 16 to 24 in. in diameter; dead-load method of driving, in which pre-cast concrete weights are placed on piles by floating cranes.

PIERS, LOUISIANA. Wharf Built in Unstable Bank, C. G. Cappel. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, p. 815. Construction of new wharf of General American Tank Storage Termins Co. at Goodhope, La., supported on H-section piles 150 ft long; details of main wharf and mooring dolphins.

PILES, STEEL. Design of Sheet Piling, F. R. Bullen. *Concrete & Constr. Eng.*, vol. 34, no. 12, Dec. 1939, pp. 651–658; vol. 35, nos. 1, 2, and 3, Jan. 1940, pp. 38–42; Feb., pp. 100–105; and Mar., pp. 144–151. Theoretical mathematical discussion of design of sheet piling functioning as retaining wall; advantages and methods of design of platform type of wall consisting of sheet piling and horizontal plate supported on raking piles at back and on sheet piles at front; numerical examples; cost data.

RETAINING WALLS, RECONSTRUCTION. Supporting Hillside During Reconstruction of Old Retaining Wall, H. S. Ayres. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, pp. 836–837. Reconstruction of cracked and leaning retaining wall, 35 ft high, supporting hillside street in Pittsburgh, Pa., without disturbing street; work accomplished by building individual counterfort walls in sheeted pits and using them to support earth of hillside by wales and sheeting, while taking down old wall and building reinforced-concrete slab wall tied to counterforts and faced with old stone.

RETAINING WALLS, STEEL. Z-Pile Wall Driven Under Traffic, G. M. Zucco. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, p. 749. Modernization of Pike Place Market in Seattle, Wash., by replacing of wood retaining wall built in 1906 with Z-type sheet piling driven just inside old wall; retaining wall extends 30 ft above ground.

HYDROLOGY AND METEOROLOGY

EVAPORATION. Better Evaporation Data Sought. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, p. 831. Use of concrete-lined circular water reservoir in Salt Lake City, Utah, having diameter of 236 ft, for experimenting with water-vapor transport method of obtaining evaporation figures; wind velocity is measured by anemometers, humidity by electric psychrometers, and temperature and humidity at water surface by hygrothermographs; evaporation calculated from instrument readings will be checked against evaporation from standard pans and against drop in reservoir level.

RUNOFF, FORESTS. Wald und Wasser, F. Meyer. *Gas- u. Wasserfach*, vol. 83, nos. 37 and 38, Sept. 14, 1940, pp. 459–464, and Sept. 21, pp. 474–477. Further observations on effect of forests on runoff in several provinces of Germany.

RUNOFF. Runoff from Small Agricultural Watersheds, D. W. Cardwell. *Agric. Eng.*, vol. 21, no. 12, Dec. 1940, pp. 479–482. Analysis of runoff data from seven agricultural watersheds in Virginia and Georgia, ranging from 13 to 59 acres in area. Bibliography. Before Am. Soc. Agric. Engrs.

INLAND WATERWAYS

RIVERS, IMPROVEMENT. Bank Protection for New River Channel, S. F. Elliot and R. R. May. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, pp. 829–831. Stabilization of sliding bank of Arkansas River in Pueblo, Colo., by drainage and by paving slope with grouted rock, keyed in to top of concrete toewall founded on rock; estimated cost of project $95,000.

IRRIGATION

CANALS, DISCHARGE. Construction Design Chart—LX—Earth Ditch Discharge—2-Ft Bottom, J. R. Griffith. *Western Construction News*, vol. 15, no. 12, Dec. 1940, p. 417. Alinement chart for computation of discharge from ditch having bottom width of 2 ft and side slope of 1 on $1^1/_2$; numerical examples.

INDIA. Irrigation Research in India. *Engineering*, vol. 150, no. 3906, Nov. 22, 1940, pp. 403–405. Review of annual report of Central Board of Irrigation, India, covering whole field of experimental irrigation in India.

LAND RECLAMATION AND DRAINAGE

AIRPORTS, DRAINAGE. Airport Drainage Is Important, W. A. Mason. *Highway Mag.*, vol. 32, Jan. 1941, pp. 7–9. Design factors of airport runway drainage systems; drain lines placed along side of runways; size and strength of drains considered.

MATERIALS TESTING

SOILS. Non-Distorting Soil Sampler, F. B. Slichter. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, pp. 756–757. Details of jack-operated soil sampler developed to reduce disturbances to samples; diagrammatic sketch of operating mechanism; use of sampler for taking undisturbed earth dam samples.

MUNICIPAL ENGINEERING

STREET LIGHTING, MONTCLAIR, N.J. Practical Lesson in Street Lighting, S. M. Weaver. *Eng. News-Rec.*, vol. 125, no. 25, Dec. 19, 1940, pp. 827–828. Abstract of paper presented before Am. Public Works Assn. discussing practical recommendations adopted by Montclair, N.J., for modernization of its street lighting at no increase in cost; light distribution patterns of refractors adopted by Montclair for better street lighting; value of refractors.

PORTS AND MARITIME STRUCTURES

BREAKWATERS, DESIGN. Het vernietigen van golven door het inspuiten van lucht, J. B. Schijf. *Ingenieur*, vol. 55, no. 41, Oct. 11, 1940 (Bouw- en Waterbouwkunde), pp. B. 121–125. Review of American, Russian, and Swedish experimental studies of design and operation of pneumatic breakwaters destroying wave action by jets of compressed air issuing from underwater pipe lines.

DRYDOCKS, ITALY. Costruzione del Quarto Bacino da Carenaggio nel Porto di Genova, A. Albertazzi and S. Allevi. *Annali dei Lavori Pubblici*, vol. 78, no. 7, July 1940, pp. 553–583, supp. plates. Design, construction, and operation of four new drydocks in port of Genoa, Italy—294 m long, 58 m wide, about 14 m deep; details of pumping plant and other equipment for operation of drydocks.

RAILROADS, STATIONS, AND TERMINALS

RAILROAD STATIONS, ROOFS. Skylight at This Station Is Built to Last. *Ry. Age*, vol. 110, no. 4, Jan. 25, 1941, pp. 216–218 and 223. Article explains how Canadian Pacific Railroad overcame difficulties met in renewing glass roof over concourse of its passenger terminal at Montreal, Quebec, and introduced new methods to offset corrosion and breakage.

ROADS AND STREETS

AIRPORT RUNWAYS. Calgary Airport Runways Completed in Record Time. *Eng. & Contract. Rec.*, vol. 53, no. 39, Sept. 25, 1940, p. 31. Material used and details of construction methods which proved successful in completing runway ahead of schedule.

AIRPORTS, PLANNING. Highway Principles and Practices Applicable to Airports, R. W. Crum. *Am. Highways*, vol. 20, no. 1, Jan. 1941, pp. 9 and 14–16. Review of lessons learned in highway engineering which can and should be applied in construction of airports; particular discussion on selection of site, runway foundations, runway surfaces, and maintenance. Before Nat. Asphalt Conference.

ALBERTA. Canada's Highway—Banff to Jasper, T. S. Mills. *Eng. J.*, vol. 23, no. 12, Dec. 1940, pp. 509–512. Report on construction of about 140 miles of high elevation highway connection between Banff and Jasper National Park, Alberta.

ASPHALT. Recent Developments in Use of Asphalt for Transportation Purposes, B. E. Gray. *Am. Soc. for Testing Matls.—Symposium*, Mtg. Mar. 6, 1940, pp. 57–65. Development of motor transport has forced changes in use of asphalt construction equipment and handling technique; present subgrade designs; effect of pavement width, improved equipment, and aggregate availability; thickness; trends in plant mixtures; asphalt surfaces for airport runways and railroad ballast.

CALIFORNIA. Roads: California Style, W. F. Faustman. *Cornell Engr.*, vol. 6, no. 4, Jan. 1941, pp. 7–10 and 24. Design policies, which have undergone intensive investigation, prove advantageous in safety and stability of roadways; specifications required and methods for their determination including bases, bituminous treated surfaces, asphalt concrete pavements, and portland cement concrete pavements; details of test track built to develop exact data for better design of low-cost roads.

CONCRETE. Specifications for Concrete Pavements and Bases, H. F. Clemmer. *Am. Concrete Inst.—J.*, vol. 12, no. 4, Feb. 1941, pp. 377–411. Text of specifications proposed by American Concrete Institute Committee 617 for concrete pavement and base materials; high early strength concrete; reinforcement steel; grading; subgrade preparation; placing concrete; installation of joints and reinforcement; finishing methods; protection of finished pavement.

CONSTRUCTION EQUIPMENT, UNITED STATES. Construction Equipment Review. *Eng. News-Rec.*, vol. 126, no. 5, Jan. 30, 1941, pp. 68–96. Collection of manufacturers' brief descriptions of construction equipment, new or substantially redesigned during 1940, including truck shovels and cranes, crawler cranes, carrying scrapers, graders, planers and rollers, excavators and loaders, haulage units, tractors, screens and crushers, concrete mixers, screeds and finishers, vibrators, bituminous equipment, air compressors, air tools, pumps, power plants, welders and small tools, etc.

ENGINEERING, CHINA. Burma Road and Industrial Development in China, C. A. Middleton

Smith. *Engineer*, vol. 170, no. 4428, Nov. 22, 1940, pp. 322–324. Discussion of imponderable forces at work in Asia that are rapidly changing industrial and social systems of large number of people in that continent; building of Burma Road has demonstrated what can be done by almost unlimited supply of Chinese man power; Japanese invasion of China has stimulated mechanization and mining developments to extent that seemed impossible 3 years ago; transport in Southeast Asia; Chinese engineers and scientists.

EXPERIMENTAL. Test Road Compares Bases of Varying Thickness. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 119–120. Description of experimental oval track at Sacramento, Calif., being used to determine comparative thicknesses of various types of stabilized or treated bases (with relatively light bituminous surface) that will give satisfactory service under light traffic on weak subgrades; longitudinal and transverse sections of test road.

HIGHWAY ENGINEERING. Some Recent Developments in Highway Engineering, A. E. Toyer. *Instn. Engrs. Australia—J.*, vol. 12, no. 12, Dec. 1940, pp. 323–329. Review of progress of highway engineering in Europe and America, with special reference to planning and design, earthworks, bituminous pavements, concrete pavements, research work, soil stabilization, and traffic aids.

HIGHWAY LIGHTING. Effects of Highway Lighting on Driver Behavior, W. P. Walker. *Pub. Roads*, vol. 21, no. 10, Dec. 1940, pp. 187–192 and 199–200. Report on research on highway lighting with object of reducing ratio of night-time to day-time accidents; evaluating effects of highway lighting from safety standpoint; passing practices on lighted sections; relations between actual and potential number of passings under various conditions; placement of vehicles under various conditions; edge clearances of passenger cars; frequency distribution of speeds.

HIGHWAY SYSTEMS. Coordination of Military and Commercial Highways, H. G. Sours. *Eng. & Contract. Rec.*, vol. 53, no. 47, Nov. 20, 1940, pp. 7–9. Need for modernized highways pointed out as vital for transport of war materials or accommodation of military trucks and tanks; service to commerce and public just as important if military needs do not become paramount. Before Canadian Good Roads Assn.

HIGHWAY SYSTEMS. Highways for Defense and Post-War Rehabilitation, T. B McQuesten. *Eng. & Contract Rec.*, vol. 53, no. 46, Nov. 13, 1940, pp. 11–12. Essential need of good roads to carry mechanized army; planning needed for post-war period.

HIGHWAY SYSTEMS, PAN-AMERICAN. Pan-American Session. *Am. Road Bldrs.' Assn.—Proc.*, Mtg. Jan. 29–Feb. 2, 1940, pp. 776–793. Symposium of following papers: Proposed Alaska Highway, C. E. Scanlan; Plan for Financing Pan-American Highway, L. M. De Oca; Pan-American Highway in Mexico, J. F. Galvez; Mexico and Control of Roadside Advertising, M. E. Bracho; Report on Activities of Pan-American Division, J. Rivera; Plan for Exchange of Professors Between Universities of United States of American and Latin American Countries, S. S. Steinberg.

HIGHWAY SYSTEMS, PENNSYLVANIA. Operating and Lighting Pennsylvania Turnpike. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 124–128. Review of first three months' operation of Pennsylvania Turnpike, with special reference to performance of lane marking and tunnel lighting; ventilation of tunnels; cost and financing.

MAINTENANCE AND REPAIR. Utah Studies Pavement Scaling. *Western Construction News*, vol. 15, no. 12, Dec. 1940, pp. 407–408. Use of synthetic resin admixtures in cement for reducing scaling of concrete paving during winter weather, especially after application of ice-melting chemicals.

MILITARY PROBLEMS. Military Highway Problems in Texas. *Eng. News-Rec.*, vol. 126, no. 3, Jan. 16, 1941, pp. 121–123. Discussion of problems of bringing roads up to modern military standards; results of survey of strategic roads in Texas revealing that 87% of them are below military requirements, and that \$80,000,000 will be required to correct poor and dangerous alinement, inadequate and narrow surfacing, lack of suitable shoulders, narrow and weak bridges, and tight underpasses.

WATER TREATMENT

FLUORINE CONTENT. Fluorine Content of Alberta Waters, O. J. Walker. *Water & Sewage*, vol. 78, nos. 11 and 12, Nov. 1940, pp. 16–17 and 42–43, and Dec., pp. 20, 26–27, and 45–46. November: Discussion of effect of fluorine on teeth; methods for determining fluorine content of water; distribution of fluorine waters in Alberta; statistics on mottled teeth. December: Reduction of fluorine content; properties of fluorine removers; removal of fluoride with alumina, phosphate, etc.; defluorite equipment; removal of fluorides by defluorite unit.

OXIDATION. Biochemical Oxidation in Acid Water Containing Sewage, C. C. Ruchhoft, M. B. Ettinger, and W. W. Walker. *Indus. & Eng. Chem.*, vol. 32, no. 10, Oct. 1940, pp. 1394–1396. Discharge of large quantities of sulfuric acid and sewage into upper Ohio River system presents stream pollution problem; results of study of problem; self-purification observed when water containing sewage and 100 to 1,000 ppm of free sulfuric acid was stored at 20 C or room temperature; comparison made of biochemical oxygen demand obtained at pH 2.7 with that in normal pH range. Before Am. Chem. Soc.

RESERVOIRS, GERMANY. Ein Stausee zur biologischen Reinigung von Flusswasser, W. Ortleb and G. Bilz. *Gesundheits-Ingenieur*, vol. 63, no. 33, Aug. 17, 1940, pp. 420–423. Principles of design of open reservoirs, within or beside river bed, for biological treatment of polluted river water to make it fit for industrial uses; design and construction of divided biological water purification reservoir at Hartmannsdorf, Germany, having capacity of nearly 2,000,000 cu m; effect of treatment in reservoirs on reduction of pollution in river water.

SOFTENING, UNITED STATES. American Water Softening Plants of Especial Interest, L. J. Alexander. *Water Works & Sewerage*, vol. 87, no. 11, Nov. 1940, pp. 520–525. First part of account of observations made during tour of 19 typical American softening plants at Oklahoma City; Topeka, Kans.; St. Louis (Mo.) County System; Mahoning Valley District, Ohio; Bloomington, Ill.; Elgin, Ill.; Canal-Winchester, Ohio; Fort Worth, Tex.

WATER WORKS ENGINEERING

ARGENTINA. La Villa de San Martin y Sus Obras de Provision de Agua, R. C. Higginson. *Boletin Obras Sanitarias de la Nacion*, vol. 4, no. 41, Nov. 1940, pp. 458–466. Town of San Martin and its water works; historical notes; town is located 43 km from capital of Province of Mendoza; present population about 10,000; 4 deep wells bored; sand troubles; two of the wells, 300 and 360 m deep, furnish satisfactory supply.

METERS, MAINTENANCE AND REPAIR. Meter Practice at Grand Rapids. *Eng. News-Rec.*, vol. 126, no. 1, Jan. 2, 1941, pp. 37–38. Review of water-meter maintenance practice of Grand Rapids, Mich., showing that small meters are more efficient and less expensive than single large ones; schedule of meter removal for testing; establishment of new meter history system; Grand Rapids service and meter code; leak prevention.

WATER TANKS AND TOWERS, MAINTENANCE AND REPAIR. Maintenance of Elevated Tanks, J. M. Perryman. *Southern Power & Industry*, vol. 58, no. 12, Dec. 1940, pp. 97–98. Need for inspection to look for rust on inside of tank, structural weaknesses, condition of ladders and balconies; preparation for painting, caulking loose rivets, safety, and cleanliness.

Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

High-Speed Scraper

A NEW HYDRAULICALLY OPERATED Carrimor scraper has been announced by the LaPlant-Choate Manufacturing Co., Inc., for use with the new rubber-tired Caterpillar tractor. It is a high-speed scraper which loads, transports at speeds up to 18 miles per hr, and spreads earth or other material under its own power. Free from overhead structural members, it can be loaded by dragline or shovel, if desired.

Fingertip hydraulic control of the scraper matches the hydraulic brakes and steering of the tractor. Many other features are reported. A low center of gravity and correct balance eliminate bobbing, weaving, twisting, and the danger of jack-knifing. The bowed design of the cutting edge makes loading easier and faster. Improved guide arrangement insures correct operation of the rear ejector gate, and the independent apron operation permits uniform spreading of any material from sand to gumbo.

The unit will be called the Carrimor CW-10 Scraper, and has a capacity of 8.75 cu yds struck, and 10 yds heaped.

New A-C Crusher

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has announced a larger gyratory size designated as their No. 636 Type "R" Crusher, having a 6-in. width of feed opening and a 36-in. diameter crushing head. It has a crushing stroke selected for a high capacity, cubically shaped product, and is suitable for handling large tonnages of stone or ore. Type "R" crushers are shipped assembled, ready to set on foundations without dismantling on arrival at the purchaser's plant.

This type crusher is of simple all-steel construction. The spider and top shell are cast integral, and readily removable for replacing of its one-piece manganese steel concave ring and head mantle. Adjustment for taking up wear on this liner and on the head mantle is easily accomplished by means of a simple oil filled hydraulic jack which supports the main shaft and is located on the bottom plate of the crusher. The jack, under normal operation, firmly holds the head and shaft in position for maintaining a uniform product, but the arrangement also readily provides adjustment for product size. The crusher is driven by means of high speed cut steel gears, located in the bottom shell and operated in a bath of oil, cooled in an external tank.

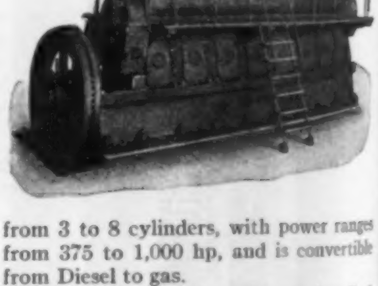
Installation Manual for Transite Pressure Pipe

A REAL WORKING MANUAL, fully indexed and crammed with factual information on all phases of pipe-laying from receiving the pipe shipment to back-filling the trench, has been developed by Johns-Manville, 22 East 40th St., New York.

This manual was designed for installation supervisors and field engineers personally concerned with the installation of a Transite pipeline. However, the information contained in its 72 pages has developed demands for the manual from engineers generally. Consequently, this manual, Form DS, Series 332, is now released for distribution to those who may wish to use it to evaluate the practicality of Transite pipe for their service, or as a handbook of up-to-date methods in pipe-laying, or for the many tables included in the appendices.

CP Diesel Engine

A MODERN DIESEL ENGINE, incorporating the latest developments in design, construction, and combustion control, is announced by the Chicago Pneumatic Tool Co., 6 East 44th St., New York, N.Y. This engine, Type 16, is of the four cycle, direct injection type, designed for continuous duty. It is available in units of



from 3 to 8 cylinders, with power ranges from 375 to 1,000 hp, and is convertible from Diesel to gas.

The features of this engine are described in Bulletin 764, available from the manufacturer.

Paving Breaker

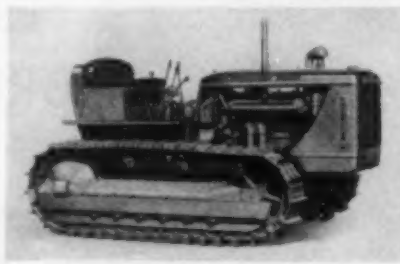
MORE POWER AND LIGHTER WEIGHT is claimed for the new No. 23 medium weight paving breaker announced by the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.

The No. 23 paving breaker is designed for general demolition of all kinds—street and wall openings, asphalt cutting, digging, and on any jobs where handling ease is the main requirement. However, it is reported to have the hard hitting power necessary for sustained demolition on the biggest construction job. Bulletin No. MC-3500 gives complete facts.

New 55 HP "Caterpillar"

A NEW 55 HP DIESEL TRACTOR, designed to provide greater capacity and speed without increased operating costs, has been announced by Caterpillar Tractor Co., Peoria, Ill.

The new D-6 tractor has nine practical working speeds. Five are forward, ranging from 1.4 to 5.8 miles an hour, and four are reverse, in the standard transmission group. An optional transmission group, giving speeds spaced from 1.7 to 5.3 miles an hour, is available. The D-6 is powered by a six-cylinder, water-cooled "Caterpillar" Diesel engine, with a bore and stroke of $4^1/_4$ in. × $5^1/_2$ in., and a full load governed rpm of 1,400. The engine is completely sealed against dust or dirt, and has only two working adjustments—the fan belt and valve clearance. Fuel and lubricating oil are filtered through special absorbent type cotton filter elements. No. 2 and No. 3 furnace oils can be used as fuel.



A wide variety of allied equipment has been designed for the new tractor. Cable controlled or hydraulically operated scrapers of 8–9 yd capacity are available. Logging arches, bulldozers, winches and other equipment fit it for almost every type of heavy-duty work.

A spark-ignition tractor, the R6, of the same horsepower, has also been announced by "Caterpillar." This machine has a 6-cylinder gasoline engine of the same bore and stroke; and features similar engineering design throughout.

Buckeye Bulldozer

THE BUCKEYE TRACTION DITCHER COMPANY, Findlay, Ohio, announces the development of new Buckeye Unitilt Cable Controlled Bulldozers and Trailbuilders for all makes and models of tractors. The name of the new design is derived from the patent tilting device and the universality of the frame, which provides for the use of either Buckeye Bulldozer or Trailbuilder moldboards on the same frame. Moldboards are dismounted from the tractor by pulling two kingpins; the sidearms and other parts stay in place. The tilting device permits raising or lowering the blade 12 in. at either end.

Other features include: construction of the front cross beam so that the blades hug the radiator, reducing front overhanging load; blade curvature which rolls the dirt ahead; 60-in. lift of blade and unlimited depth of cut below ground level; sidearms mounted at drive axle of tractor; rigid, fully braced members to withstand all types of 'dozing work. Literature and specifications are available on request.

Radial-Cone Bottom Elevated Water Tanks

A NEW 20-PAGE BULLETIN just issued by the Chicago Bridge & Iron Co., 332 South Michigan Ave., Chicago, Ill., contains illustrations of both structural and cylindrical column installations of radial-cone bottom elevated water tanks ranging from 125,000 to 2,000,000 gals capacity. Although this design of water tank is most economical in capacities of 750,000 gals or over, many engineers have found the advantages of appearance and low range in hand sufficiently important to use it in smaller sizes.

The illustrations in the bulletin are arranged so that it is easy to compare different construction features such as cylindrical or structural columns, cone or ellipsoidal roofs, curved or straight shells and spiral stairs and vertical ladders. A table of standard sizes is also included.

New Chain-Belt Filters

THE HALVORSON-SMITH PROCESS of sewage treatment is not new to the sewage treatment field. Over 50 plants in operation prove the firm foundation of the process. It is new, however, that the Chain Belt Co. of Milwaukee, Wis., announces its connection with the process.

Reliable design data, based on operating results, is now offered. Standards have been established, not only for filter loadings, but also for settling tanks, pumps, ventilation, etc. A new Bulletin, No. 329, with 30 pages of text, illustrations, flow diagrams, and operating data, outlines all the factors which contribute to a low first cost, low operating cost, and high degree of purification.

Steel Scaffold

A NEW SAFETY steel scaffold, for use by building contractors, maintenance departments of private and public buildings, etc., has recently been placed on the market by Mechanical Handling Systems, Inc., 4600 Nancy Ave., Detroit, Mich., under the trade name, "Quik-Set Safety Scaffold."

Designed on simple, gravity-locking principles, "Quik-Set" scaffold is reported to provide extreme interchangeability with a minimum number of separate units. No screws, bolts, or clamps are used, and no tools of any kind are required to erect or dis-assemble. The scaffold consists of square-section tubular steel brace and corner post units, of rigid construction with electrically welded parts. The design of the various units permits erection in straight line, in corners, around rectangular or circular constructions. Bridging over obstructions is accomplished with simple truss units.

In addition to the scaffold side and vertical units, steel floor sections, detachable ladders, adjustment posts for erection on uneven surfaces, brackets for catwalks and for holding material, casters for use on interior work, and a simple, safe skip hoist for lifting materials, are provided. This "Quik-Set" scaffold may be leased or purchased.

Literature Available

AIRPORT DRAINAGE—"Planes Must Land" is the title of a folder on airport drainage. Armco Drainage Products Association, Middletown, Ohio.

BATCHING PLANTS—Portable and semi-portable charging plants of all types for aggregate and bulk cement are covered in Bulletin B-31. Heltzel Steel Form and Iron Co., Warren, Ohio.

BITUMINOUS MIXING—"1940 Performance Data and Laboratory Reports" is a new booklet issued by Barber-Greene Co., Aurora, Ill. It is chiefly a report on four carefully separated central plant bituminous jobs applying the continuous production principle to the "higher type" bituminous mixes. Though adequately illustrated, this is not a picture book. It will be of vital interest to all who are seriously engaged in specifying, producing or using the high type bituminous mixes.

CATERPILLAR CATALOG—Caterpillar Tractor Co., Peoria, Ill., has just issued a 36-page, two-color catalog, Form 6425, listing the more than 50 products which are manufactured by the Company. Sections are devoted to "Caterpillar" Track-type tractors, road machinery, Diesel and natural gas engines, Diesel Marine engines, Diesel automotive engines, and Diesel and natural gas electric sets. Each of the products is illustrated, and brief specifications are given.

EARTH DRILL—The Buda-Hubron Earth Drill and its many applications for drilling to a maximum depth of 50 ft and 42 in. diameter are described in Bulletin 1019, Buda Co., Harvey, Ill.

MONEL, NICKEL AND INCONEL—Bulletin T-19 contains information on the mechanical characteristics of the high nickel alloys as compared to other materials commonly used in deep drawing. The bulletin covers die materials, lubricants, and drawing practice, along with general information on annealing and pickling of Monel, nickel, and Inconel.

PURE WATER—A complete small portable water plant that can be placed in a truck (weighs only 750 lbs) for the purification of construction camp water—the Pur-O-Pumper—is described by Proportioneers, Inc., 14 Codding St., Providence, R.I.

SHOVELS—A new 16 page illustrated catalog, No. 1885, has been completed by Link-Belt Speeder Corporation, 301 West Pershing Road, Chicago, Ill., on its 2 to 3 cu yd Speed-O-Matic Series "800" shovels, draglines, cranes.

TRACING CLOTH—The 1941 catalog of Arkwright Finishing Co., Turks Head Bldg., Providence, R.I., comes in a handy $6^1/_2 \times 3^1/_4$ in. size, and carries samples of Arkwright tracing cloth, Prudence tracing cloth, Matsurf, Arkwright pencil tracing cloth and Arkwright pencil cloth.

WATERPROOFED CONCRETE—The needs, methods, materials and specifications for waterproofed concrete are included in a 32 page booklet. Medusa Portland Cement Co., 1099 Midland Bldg., Cleveland, Ohio.

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